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Hot Water Central Station Heating

A TUNNEL SYSTEM FOR SUPPLYING HOT WATER HEAT AND DOMESTIC WATER SUPPLY TO A NUMBER OF SCATTERED BUILDINGS FROM A CENTRAL PLANT AT NELA PARK, EAST CLEVELAND, OHIO

FOR ITS MANY lamp factories situated in different cities throughout the country, the National Lamp Co. of the General Electric Co., has established a headquarters on a hilltop east of Cleveland, where there are now in operation buildings for administrative, experimental and testing purposes, controlling the entire output of the various constituent factories. Here is carried on the purchasing of all materials required, the testing of these materials, the administrative and accounting functions of the organization, an experimental laboratory for the development of new types of lamps, and a factory for the manufacture of such experimental lamps. The location chosen is ideal, as it is away from the city dust and noise, with plenty of room for expansion and at one side space for the building of houses for the employes, and athletic grounds, though these are not yet started. Eight large buildings occupy an area of several acres, according to a definite design, and for supplying the needs of these buildings and their occupants as to heat and water supply, a central plant has been erected which

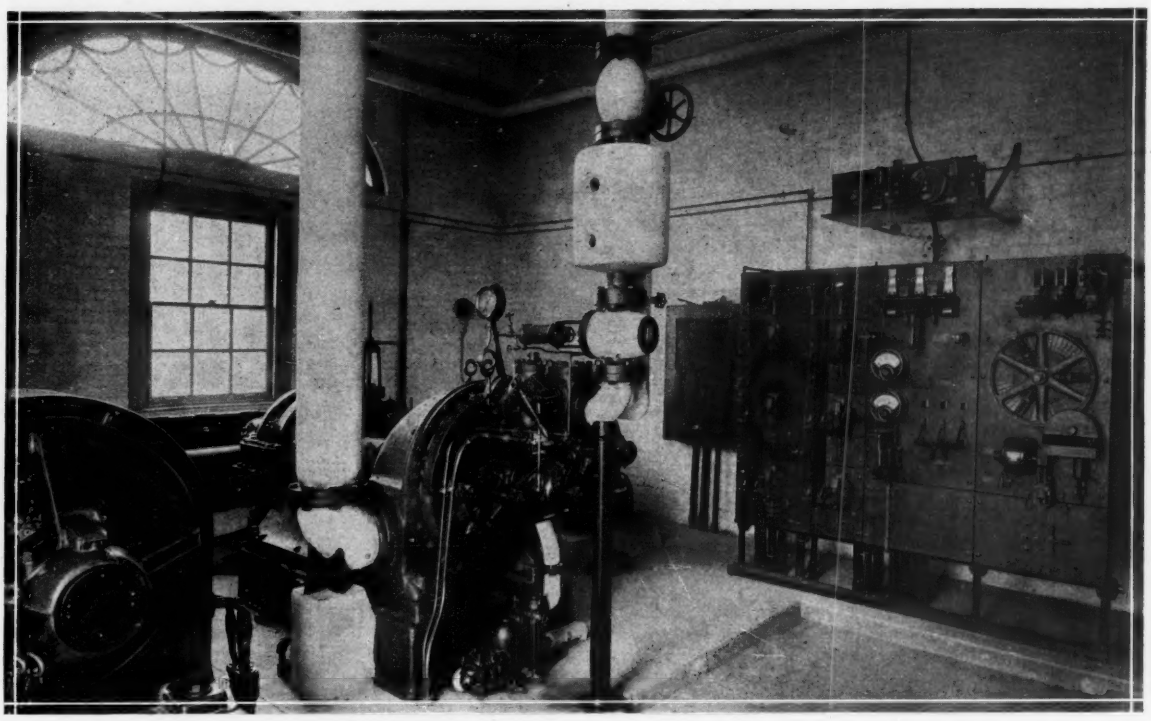


FIG. 10. VIEW IN THE POWER HOUSE SHOWING FIRE PUMPS AND AUTOMATIC PRESSURE CONTROL BOARD FOR HOUSE WATER SERVICE

has a number of novel features and embodies the latest engineering practice in this line.

Distribution is, naturally, through tunnels and these have been so located that they are under the walks connecting the different buildings, thus furnishing a substantial foundation for the walks and at the same time, as these tunnels are heated by the steam and hot water, serving to keep the walks dry in wet and snowy weather. Electrical conductors are carried in the same mains, the current being supplied by the Cleveland Electric Illuminating Co., at 11,000 volts to a central switchboard and there transformed into 440 volts, 3-phase, in which condition it is supplied to the motors about the buildings and also to local transformers which step it down to 110 volts for the lighting system.

Heat is supplied to the buildings by hot water circulation from the central plant, the water being heated by steam from a battery of boilers and circulated by means of centrifugal pumps. Combined with this is a pumping system for fire protection and house supply of both cold and hot water.

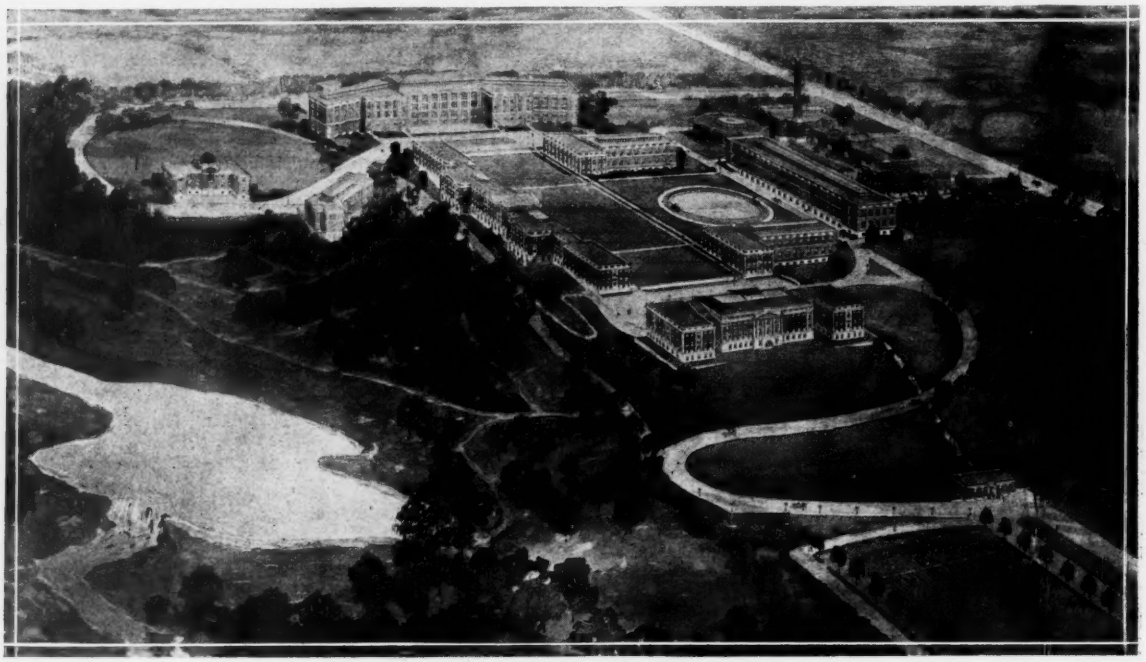


FIG. 1. GENERAL VIEW OF NELA PARK

Boiler Room Installation

The original source of heat is the boiler room, containing 4 250-hp. Stirling boilers carrying from 125 to 150 lb. pressure, which is used direct for driving the turbines in the pumping plant and is reduced for use in the heater and for supplying steam for special purposes to the different buildings. These boilers are set in batteries of 2, and are stoker-fired, the water supply being controlled by Williams safety water columns and feed water regulators.

Coal storage is in underground pits having a capacity of 1000 tons, into which the coal is dropped by gravity from trucks. From this pit it is raised by bucket elevators of simple type and delivered to the hoppers in front of the boilers, each hopper having a capacity of 11 tons. Ashes drop by gravity to a car under these and are dumped into an ash hopper from which an elevator raises them and delivers them to trucks to be carted away for filling.

This boiler equipment is provided to supply steam to 125,000 sq. ft. of radiating surface, which will be the ultimate installation when the contemplated buildings are all completed, as well as supplying power for future steam turbine electrical units for power and lights. At the present time, the supply is to 45,548 sq. ft. of radiation, and only a part of the boiler plant is in service.

To provide an ample supply of feed water, regardless of city conditions, an open reservoir is provided in the center of the park, having capacity of 1,000,000 gal. and supplied by city pressure direct, the pressure available at this point being 15 lb. From this reservoir the water is taken through Loomis-Manning filters; centrifugal pumps drawing the water from a suction well beneath the pump house which is connected to the reservoir by 2 12-in. mains, force the water through these filters and from them it goes to the circulating pump which supplies the domestic water system and also to the boiler feed pump supply line. The house supply is maintained at a pressure of 35 to 45 lb., and the boiler feed is furnished by 2 Davidson boiler feed pumps located in the boiler room.

Heating System

Water for the heating system is kept in circulation by a DeLaval centrifugal pump driven by a 110-hp. General Electric horizontal steam turbine running at 2250 r.p.m. and having a capacity of 2500 gal. per

minute, under 120 ft. head. As a reserve unit, a similar pump is provided driven by a 125-hp. General Electric 3-phase motor running at 1780 r.p.m. The water is heated by exhaust steam from the different turbine pump units and by live steam from the boilers when necessary, the heater being of a new 2-pass type with floating head.

Hot Water Heaters

This heater for the hot water heating system, which was furnished by the Alberger Heater Co., of Buffalo, N. Y., is probably the largest ever built, the completed weight being 14 tons and the copper tubing weighing a little over 4 tons. It is of the standard water-tube design and construction of the company for this class of work, the water passing through the heater twice. At one end the tubes are made fast in the stationary head and at the other end are carried in a floating tube head, which permits of expansion and contraction of the tubes independently of the cast-iron shell. This is necessary because of the difference in temperature of the shell and the tubes, caused by temperature changes of the water. Expansion and contraction is a force that must be provided for or serious fracture would result. With the floating tube heads, no packings are necessary around the tubes and all tubes can expand or contract easily without unequal strains.

The illustrations show the section of the floating head, also a view of the water inlet and outlet end, with the partition plate which directs the flow of water through the heater, the stay bolts which add strength to the heads for the high pressures used and also the floating tube head with its cover in place, and the stay bolts to support that cover. The placing of both water inlet and outlet connections at one end of the heater permits of a convenient piping layout and makes it possible to separate the water piping and steam piping.

The heaters are made for either exhaust or high pressure steam, and a combination heater is often furnished which provides for the use of exhaust steam when available, and for automatic supplementary admission of live steam if the exhaust does not heat the water to the desired temperature.

In addition to this heater for the hot water heating system, a live steam heater is installed in the plant of the same design and made of the same materials. Also, for the domestic supply, a heater is installed, which has a series of floating tube heads at one end so as to permit the several groups of tubes to expand or contract free

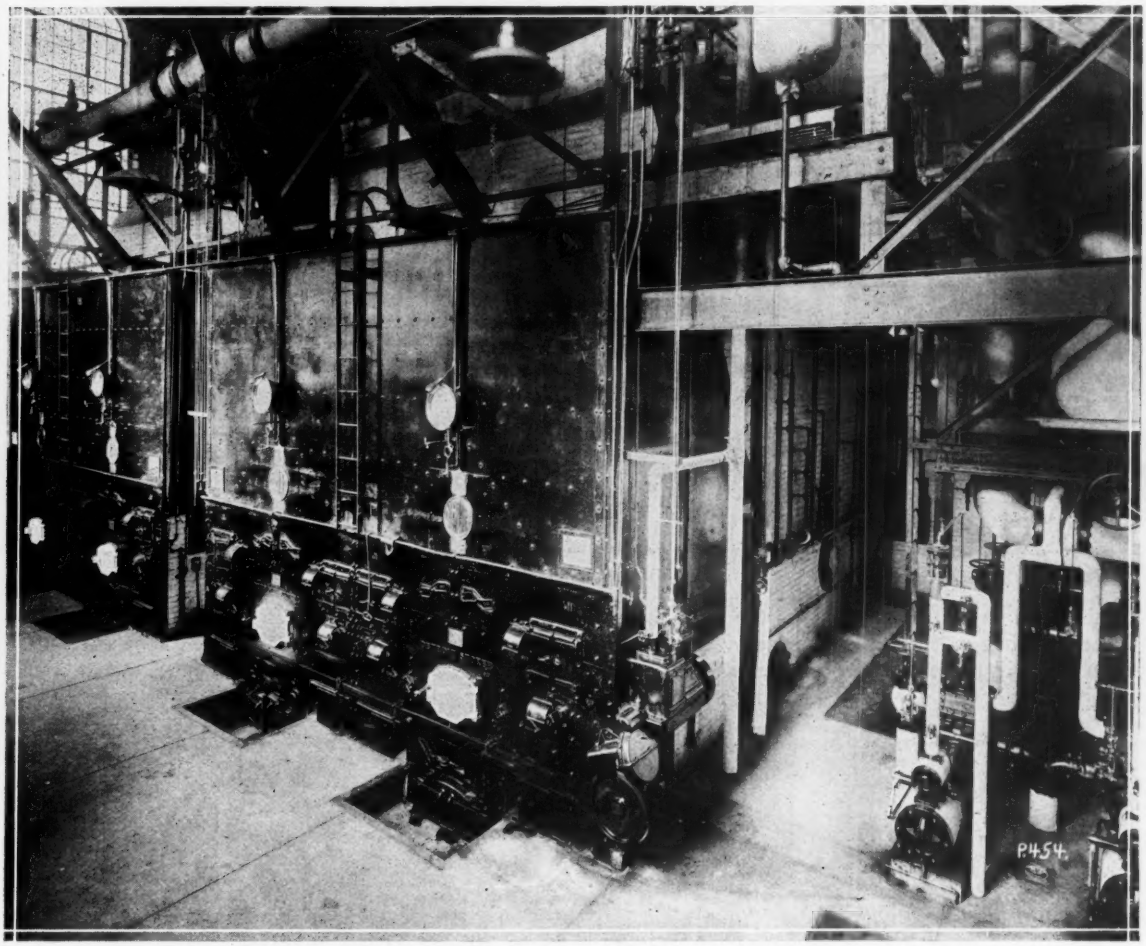


FIG. 2. VIEW OF BOILER ROOM. BOILER FEED PUMPS AND HOT WATER HEATERS AT RIGHT

of each other. Water enters this heater at 40 deg. and leaves at a temperature practically that of the steam, so that the tubes on one side must expand much more than those on the other. The use of several floating heads makes this possible.

floating heads, a double pass of the water through the heater being made for each head, and the chamber at the water end being divided by several partitions instead of by one.

Accessibility to this type of heater is an important

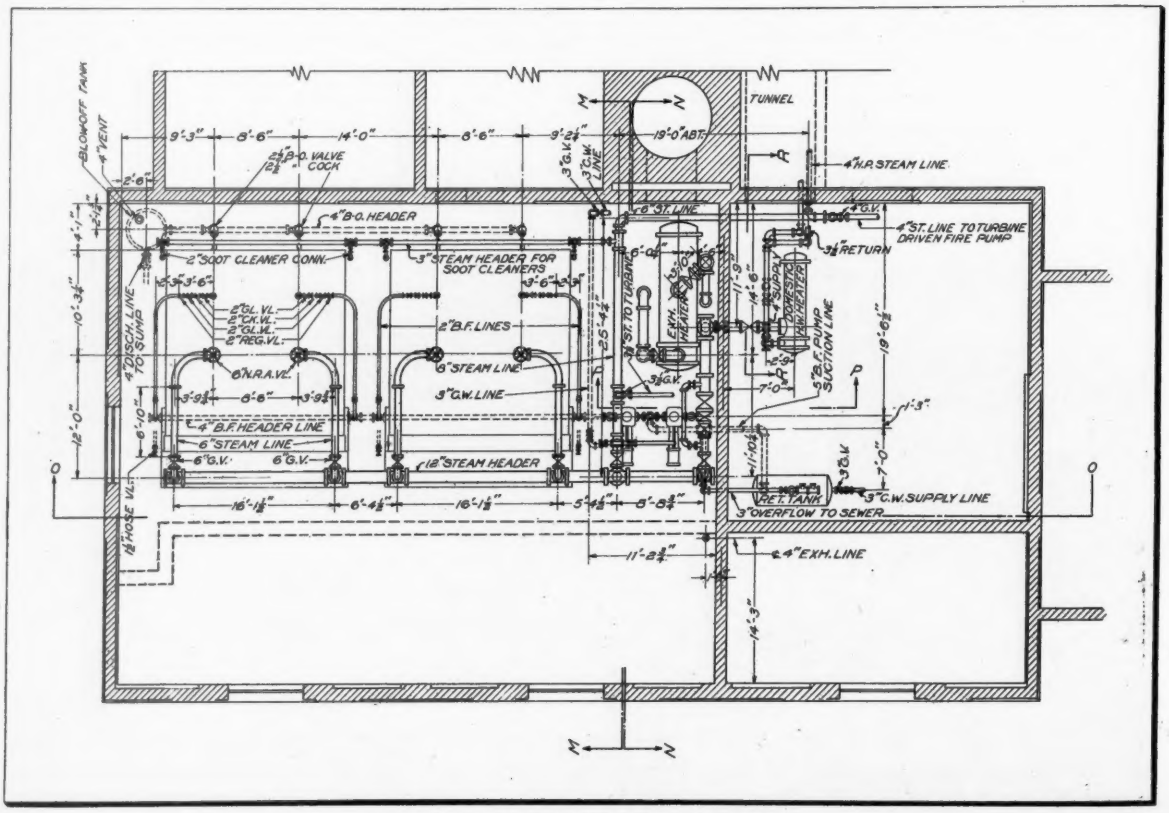


FIG. 3. PLAN OF BOILER ROOM PIPING

This multi-pass type of heater is the one used as a standard for hot water heating service by the Alberger Heater Co., and the construction is the same as for the 2-pass shown herewith, except that there are several

feature. In order to get at the heating surface or the tubes, it is only necessary to remove the covers at the ends of the heater, which does not necessitate breaking steam or water connections or removing pipe covering.

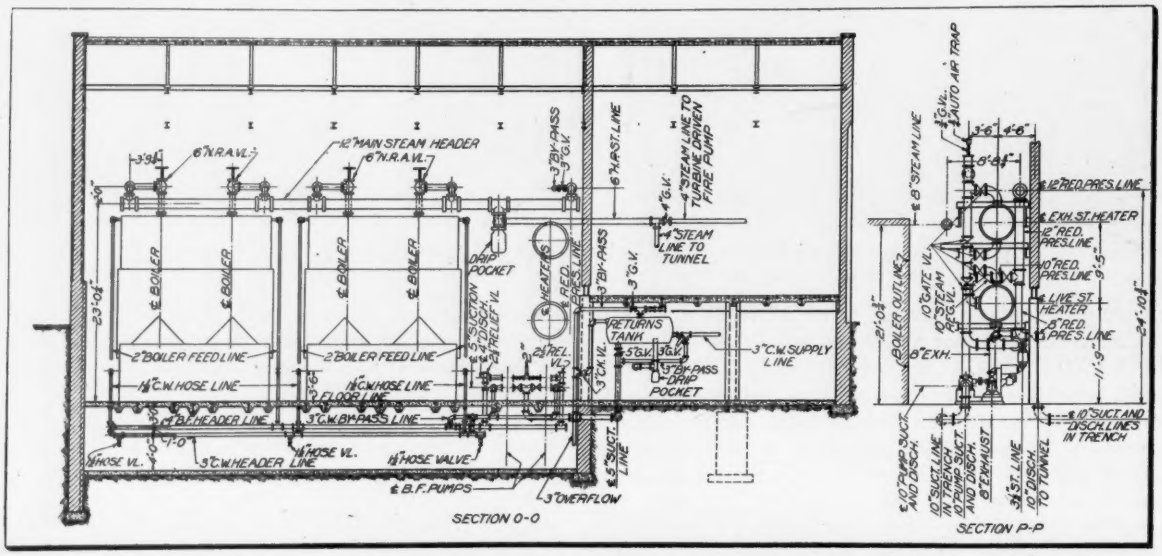


FIG. 4. LONGITUDINAL SECTION OF BOILER ROOM SHOWING MAIN STEAM PIPING AND HEATER CONNECTIONS

Temperature of the water in the heating system is controlled by a Tagliabue controller which, when set for zero degrees outside temperature, gives 185 deg. temperature of the outgoing water in the heating system. This controller can be set to control the outgoing temperature from 125 deg. up to 245 deg., depending on the outdoor temperature, and the return temperature in the heating mains will be from 10 to 20 deg. less than the outgoing temperature when all buildings are on the system. To provide for the expansion of the hot water, a tank is installed in the heating plant, the cushion being provided by air pressure which is controlled according to the temperature of the water, and the overflow is cared for by a relief valve. The velocity of the water in the heating mains is 9 ft. per second and in the supply and drop pipes, 3 ft. per second.

Hot water for washrooms and other domestic purposes is supplied by a DeLaval pump driven by a General Electric motor, having a capacity of 350 gal. a minute at 60 ft. head, and is carried through 4-in. outgoing mains and 3-in. return mains, the water being kept in constant circulation in order to maintain its temperature at the fixtures. The temperature is controlled by a thermostatic apparatus on the Fulton automatic system.

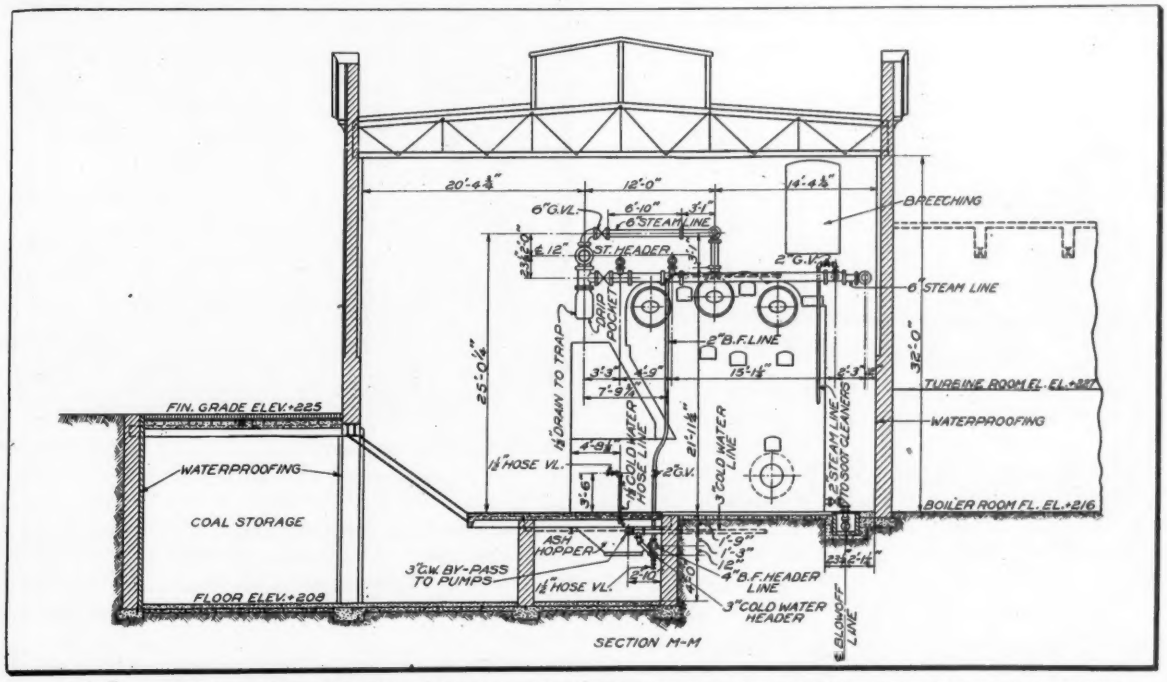


FIG. 5. VERTICAL SECTION OF BOILER ROOM SHOWING STEAM PIPING AND ARRANGEMENT FOR COAL STORAGE

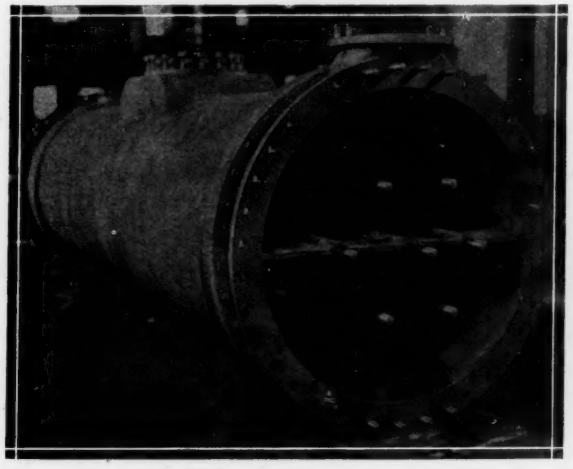


FIG. 6A. WATER END OF HEATER WITH COVER REMOVED SHOWING INLET AND OUTLET CONNECTIONS AND DIVISION PLATE

FIG. 6B. VIEW OF FLOATING TUBE HEAD WITH ITS COVER REINFORCED WITH STAY BOLTS

As steam is needed in the restaurant and in some other buildings for special purposes, a 6-in. steam main is carried through the tunnels with pressure of 50 lb., and branch pipes are taken off wherever necessary. At

all points, where necessary, throughout the system drips are installed, the condensation being carried away by V. D. Anderson Co.'s steam traps. Also for special uses, artificial and natural gas are supplied to all buildings through 4-in. mains.

Cold Water Supply

To furnish water for closets and washrooms, a 6-in. cold water main is carried in the tunnels, water being forced into this by a 6-in. DeLaval pump under 40 lb.

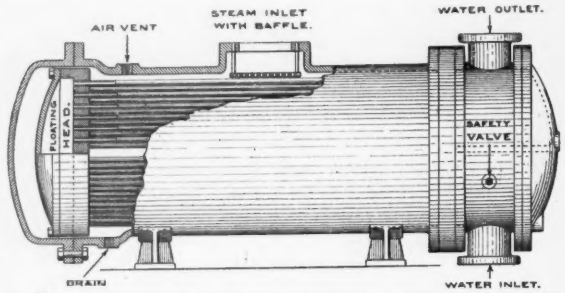


FIG. 7. LONGITUDINAL, PART SECTIONAL VIEW OF THE 2-PASS HEATER

pressure, as already stated. The water in this system is also kept in constant circulation, presumably to avoid stagnation and prevent any freezing in the pipes or fixtures. Water mains for all systems are arranged in loop form, so that water always flows in the same direction avoiding chance for short-circuiting or dead ends or dead sections near any building; no throttling by valves is needed, therefore, in order to force flow to any part of the system.

For fire protection, 2 pumps are installed, each with a capacity of 1500 gal. a minute, against 236 ft. head. Both of these are DeLaval 2-stage pumps, one being operated by a turbine, the other by a 3-phase electric motor. A standby unit is provided to keep up pressure on the fire mains, consisting of a 3-in., 3-stage DeLaval pump of 200 gal. a minute capacity, driven by an induction motor and automatically controlled by a General Electric contactor, which operates on 5 lb. variation of pressure in the mains. To serve as an air cushion for the different systems, 2 tanks are provided, each having a capacity of 7500 gal. and being half filled with air. One of these is connected to the domestic water supply and one to the fire system.

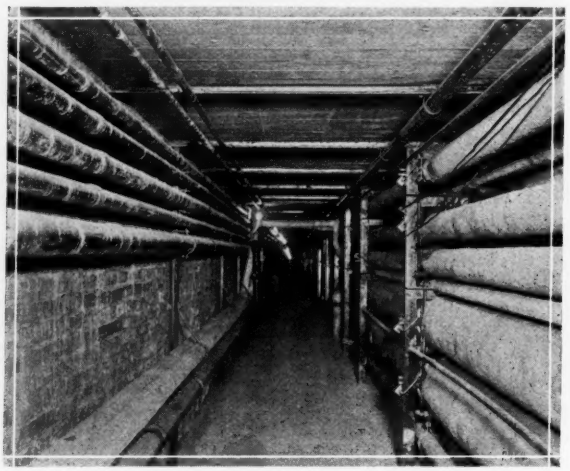


FIG. 9. PIPE TUNNEL SHOWING REMOVABLE-FRONT SUPPORT AT RIGHT

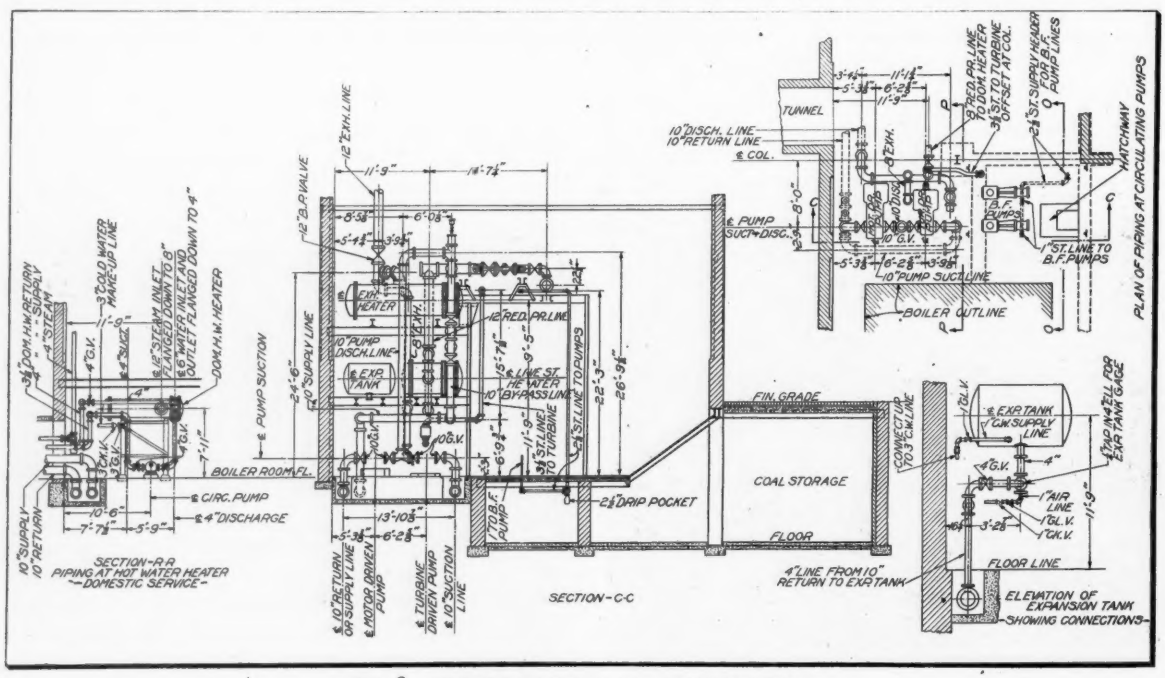


FIG. 8. DETAILS OF PUMP AND HEATER PIPING

Both of these are DeLaval 2-stage pumps, one being operated by a turbine, the other by a 3-phase electric motor. A standby unit is provided to keep up pressure on the fire mains, consisting of a 3-in., 3-stage DeLaval pump of 200 gal. a minute capacity, driven by an induction

As Nela Park is situated at 220 ft. above Lake Erie, while Euclid Ave., in which the East Cleveland city

mains run, is only 90 ft. above the lake, and a pressure of 40 lb. is maintained on the city service, the park system is enabled to help out the city service in emergency fire demand. The distance from the city pumping station is considerable and when there is any draft on the water system, the local pressure drops to such a point that it is not sufficient for fire purposes. Under such conditions the supply from the Nela Park reservoir can be turned directly into the city mains or can be pumped into the mains through the Nela Park fire pump. This emergency service has been called into use several times during the operation of the plant.

For use in the restaurant and drinking fountains, water is supplied in bottles, after being treated in a Forbes sterilizer, and ice for cooling the water is manufactured by the use of the Audiffren-Singrun apparatus supplied by the H. W. Johns-Manville Co. This apparatus is installed in a special room near the heating plant, which is a part of the switchboard building.

Tunnels for carrying the different piping systems are of concrete, 7 ft. in height and running to all buildings. The pipes are installed on the sides of the tunnel, carried on hangers of special design which are removable, so that any length of pipe can be got at for repairs or changes and can be taken out sidewise without having to disturb other pipes. Electric light is, of course, provided in all tunnels, and a drainage system carries all moisture to a sump pit, from which it is pumped into the sewers by a special sump outfit.

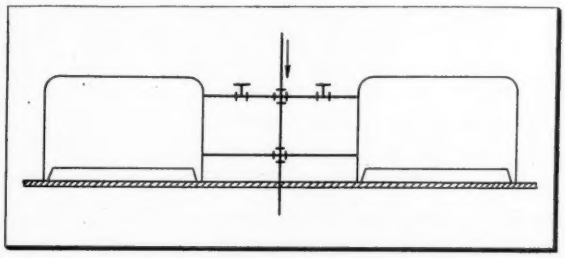


FIG. 11. TYPICAL CONNECTION TO RADIATORS IN OFFICE BUILDINGS

For heating the office buildings, direct heating floor radiators, manufactured by the American Radiator Co., are used, connected to down-flow supply pipes, as shown in the illustration. It is found that this method of connection works satisfactorily and no difficulty is experienced in getting circulation throughout the system.

In the factory buildings wall radiators are used instead of pipe coils, the connections being from a down-flow feed pipe with double Y branches, as shown. The radiators are installed in 2 sections, the supply going into the top of the upper section and the outlet leaving the bottom of the lower section, connection between the 2 sections being at the far end. A distance piece is supplied between the near ends for support, and the radiators are carried on specially designed hangers, 2 to each radiator, thus simplifying the installation and permitting of keeping the radiators close to the wall. On each floor 2 radiators are connected to each down-flow pipe, the buildings being 4 stories in height, so that each 1½-in. flow pipe supplies 8 radiators running in capacity from 54, 72 or 92 sq. ft. each, according to the space served.

Construction of the entire plant has been carried out by the Samuel Austin & Son Co., of Cleveland, the heating and water supply systems being designed and superintended by Wm. H. Smead, manager of the Heating & Equipment Department.

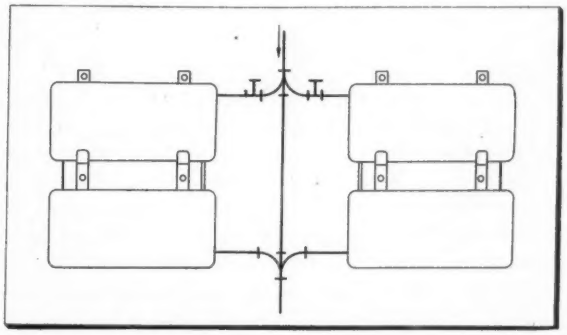


FIG. 12. CONNECTIONS USED FOR RADIATORS IN THE SHOP

This group of buildings was designed by Wallis and Goodwillie, architects of New York City. The general arrangement of apparatus and special equipment was laid out and designed by the Construction Dept. of the National Lamp Co., of the G. E. Co., under the direction of J. R. Massey, construction engineer.

IN REPORTING on the Ohio Valley flood of last spring, and precautions which may be taken to prevent similar disasters in the future, the United States Geological Survey estimates that the direct material loss was more than $200,000,000, without considering the indirect losses or loss of life. To prevent floods and the damage done by floods, the Survey recommends that both control of headwaters by means of storage reservoirs and levees along the river bank to prevent overflowing, should be used, as no one means can possibly be adequate. It is shown that to have prevented the floods of various years at Cincinnati from rising above the danger line would have required the storage of 226,000,000 cu. ft. of water, the accumulated excess during the 19 days that the height of the river was above the danger line. Surveys of available reservoir sites above Pittsburgh show 43 with capacity of 80,500,000 cu. ft. and preliminary investigations in the Kanawha River drainage area show 17 sites, with an additional capacity of about 280,000,000 cu. ft. Other available sites are found on other tributaries of the Ohio above Cincinnati, and it is probable that even greater storage capacity than the Survey mentions would be required to control fully the floods, as all floods do not originate on the same tributaries, and sufficient reservoirs must be provided for control of combinations of 2 or more tributaries. Whatever scheme is adopted, it is certainly necessary that any possible plan of action should be started on at once to avoid loss of life and property which has occurred in the past years. Such a system must be under Federal control, as it has to take into account that the river passes through several states, and must deal with the problem in a broad way.

Acceptance Tests of Steam Turbines

Working Up Test Data Obtained When Conditions Were Not Those Specified by the Contract. By W. J. A. London

UNLIKE the reciprocating engine where guarantees are made generally on pounds of steam per indicated horsepower, the steam turbine possesses no such equivalent rating, and the guarantees have to be made on an absolute shaft horsepower basis. With turbine installations, therefore, the methods employed for determining even an approximate idea of the performance, require much more elaborate preparations than the attachment of a simple indicator.

In Europe the custom prevails that when a manufacturer makes a guarantee, he is often called upon to demonstrate to the satisfaction of the purchaser, that he has made good on his guarantee after installation. Conditions, however, are different in America, and it is generally considered here that if a reputable concern makes a guarantee, it is up to the customer to show by tests carried out after installation at his (the customer's) own expense, that the guarantees made have not been met if he feels any doubt about the matter. Shop tests, therefore, often constitute final acceptance tests, as it is often an expensive procedure to make any part of a reliable test after installation. This is particularly so where jet condensers are installed.

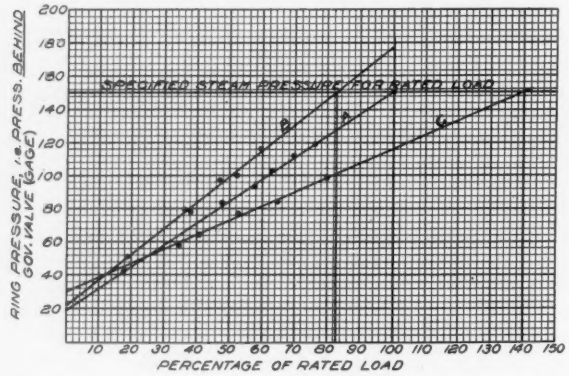


FIG. 1. CURVE FOR DETERMINING PERFORMANCE OF STEAM TURBINE AT PRESSURES NOT ATTAINABLE IN PLANT

No contractor ever objects to the customer's witnessing shop tests, and in a great majority of cases, the shop tests are by far more satisfactory than station tests, inasmuch as the manufacturer is generally equipped with better testing apparatus than could be rigged up satisfactorily in a power house.

Correction for Conditions

Of course, it often happens that contract conditions are unavailable at the manufacturer's testing plant and it is out of the question to expect the manufacturer to keep modifying his equipment to meet the ever changing increase in pressure and superheat conditions of the newer power houses. Particularly is this a condition with Naval and Government work generally where steam pressures of 250 to 350 lb. are becoming standard, and the amount of work obtainable from this one customer by any one contractor would not reimburse him sufficiently for laying down plant to get absolute guaranteed conditions.

The Government appreciates this and accepts tests under conditions approximating as closely as possible to those guaranteed; but with government work this shop test constitutes only a preliminary test, final tests being made after installation under actual guaranteed conditions.

In commercial work, shop tests, for the reasons mentioned above, often constitute the final, in fact, the only test to which the machine is ever subjected.

Even in commercial work, the manufacturer is often unable to obtain contract conditions, and the question therefore arises as to how accurately can corrections be made for the varying conditions; or in other words,

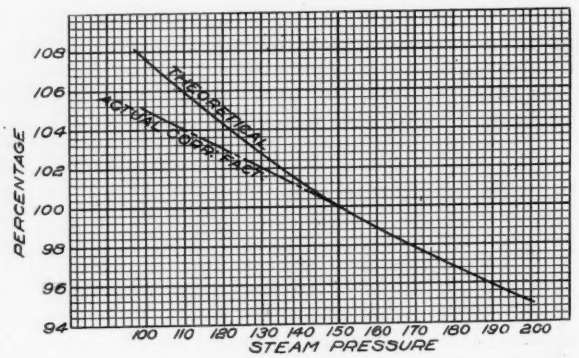


FIG. 2. CORRECTIONS FOR STEAM PRESSURE ON CONDENSING TURBINE

when a test is made, at say partial load, with low steam pressure and low vacuum, can we make corrections that will give us a true line on what the performance of the machine will be after installation? And further (and this is of more importance still), granted that the manufacturer knows absolutely the accuracy of these corrections, how can he satisfy the layman that his reasons and interpolations are what he claims?

The corrections called for consist of one or more of the following conditions: Load, steam pressure, superheat or quality, and vacuum.

Load

Because of the rapidly increasing size of individual turbine units, full load tests on a machine in the manufacturer's works are often out of the question. The capital outlay for boilers and condensing plant would be prohibitive, but the law governing the performance of any turbine (or reciprocating engine for that matter) is so simple that partial load tests give an accurate line on the performance of any machine at full load. The

Willans straight line law for total water is so thoroughly reliable that after setting valves, etc., for full load conditions, a series of points at partial loads will be found to give absolutely the performance that will be obtained under full load conditions. The Willans line, of course, is true absolutely only where brake readings are taken, and when tests are made with generators, this line may have a slight curvature due to the varying efficiency of the generator at different loads. The characteristic of the generator can, however, easily be determined and corrections made to bring the total water to a brake horsepower basis.

A ring pressure curve, as shown in Fig. 1, will give the actual full load obtainable under contract operating conditions with a given valve setting, and will show clearly what the actual full load rating on the machine is.

Referring to Fig. 1, the ideal machine designed for 150 lb. pressure and a load of 100 per cent would have a characteristic line as shown by A. If the machine is

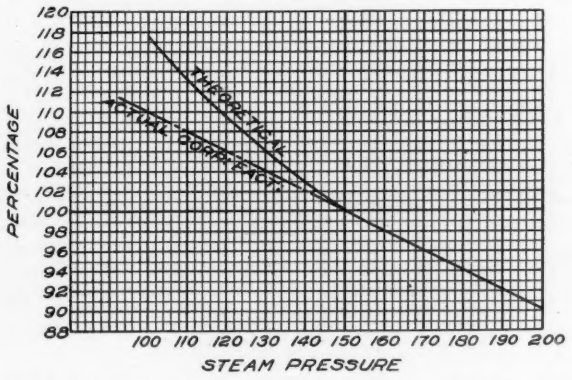


FIG. 3. CORRECTION FOR STEAM PRESSURE ON NONCONDENSING TURBINE

too small for the rated load, the characteristic will follow probably the line B giving at 150 lb. only a load of 82½ per cent, or, in other words, a steam pressure of 178 would be necessary to give full load. Supposing the characteristic falls along the line C, then the machine in question, with 150 lb. steam, is good for a load of 140 per cent, and this will be the point of maximum economy. The pressures referred to in taking these readings are, of course, those behind the governor valve and not the line pressure.

Steam Pressure

In standard condensing machines, a correction of 1 per cent for each 10 lb. difference in steam pressure between, say 120 and 180 lb. steam, is generally accepted without comment. That this factor closely approximates the actual difference in B.t.u. available (assuming a vacuum of 28 in.) is shown by the following table, 150 lb. being considered unity. These figures are also plotted on Fig. 2 and while it would seem that at the lower pressures a higher correction factor should be used, it must be borne in mind that in most commercial machines the actual thermal efficiency of the machine is better at the lower pressure, making the correction factor less than the theoretical, while the table given has assumed the same thermal efficiency throughout.

Gage Press.	200	180	160	150	140	120	100
H_1	1198.9	1190.9	1190.2	1193.3	1188.1	1184.7	1187.8
H_2	859.9	859.9	865.5	871.1	871.1	876.8	888
B.t.u. Avail.	339.	331.	324.7	322.2	317.	307.9	299.8
Per cent Differ.	.95	.974	.993	1.00	1.017	1.047	1.075

NOTE.—B.t.u. Drops are taken in Entropy nearest to dry steam at initial pressure, also at nearest tabulated pressures.

In noncondensing machines, conditions are, however, materially different, calling for different correction. Comparing the difference in B.t.u. drop in the 2 instances, we get the following:

	Noncondensing			Condensing 28" Vac.			
Gage Press.	200	150	100	200	150	100	
H_1	1198.9	1193.3	1187.8	1198.9	1193.3	1187.8	
H_2	1004.6	1018.0	1038.1	859.9	871.1	888.	
B.t.u. Avail.	194.3	175.3	149.7	339.	322.2	299.8	
Per cent Differ.	.902	1.00	1.172	.95	1.00	1.075	

In noncondensing machines, therefore, the correction factor will be approximately in the neighborhood of that shown in Fig. 3.

Superheat

Superheat corrections are probably the most standardized of any. Irrespective of the type of turbine, tests have shown a universal saving of 1 per cent for each 10 deg. F. of superheat up to 100 deg. This closely follows the ratio of the absolute temperatures of the steam.

For superheat above 100 deg., the curve begins to fall, giving about 13 per cent at 150 deg., and 16 to 18 per cent at 200 deg. These higher temperatures are not often met with in practice and the corrections up to 100 deg. or 125 deg. generally cover our requirements.

Corrections for Moisture

While the theoretical correction for entrained moisture is 1 per cent for each 1 per cent of moisture, careful tests have shown that a correction of 2 per cent for each 1 per cent of moisture represents the figure more frequently found in turbine work. The additional friction that results from the presence of moisture is responsible for the additional 1 per cent. This has been repeatedly verified by reputable manufacturers and is now considered standard for turbine work.

When more than 2 per cent is present in the steam entering the turbine, the throttling calorimeter should not be used, except as a very rough approximation; either a separating calorimeter or else the Thomas Electric Calorimeter should be used when moisture in excess of 2 per cent is present.

Vacuum

Vacuum corrections are the most variable of all and it is difficult to formulate any law covering satisfactorily the percentage gain or loss with various degrees of vacuum. A test made at a manufacturer's plant must necessarily be with temporary piping; it is, there-

fore, generally impossible to obtain anything like the high degree of vacuum obtainable in power houses with permanent piping. A vacuum of 28½ to 29 in. is now common in power houses, but a vacuum of 27 in. in a manufacturer's testing power plant is considered good. The correction for each inch of vacuum between, say, 27 in. and 29 in. is often assumed to be in the neighborhood of 4 to 5 per cent per inch. This figure is a fair

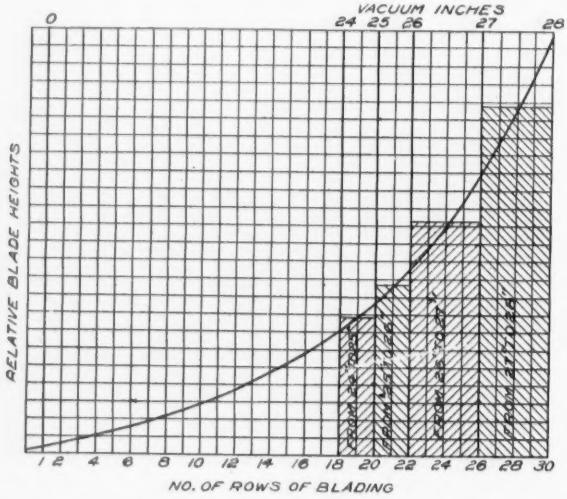


FIG. 4. COMPARATIVE AREAS REQUIRED IN LOW PRESSURE STAGES OF A PARSONS TURBINE SHOWING RELATIVE INCREASE IN BLADE AREA REQUIRED FOR INCREASING VACUUM

average of the results obtained, and, where approximate figures only are required, is a safe assumption; but where accurate correction factors are required, this figure cannot be relied upon with any certainty. The gain that will be obtained by increasing the vacuum say, from 28 to 29 in., will depend entirely on whether the turbine in question has been properly designed to take care efficiently of the additional energy due to this increase in vacuum. In other words, the vacuum corrections are entirely dependent upon the design of the machine. It stands to reason that with a machine designed to operate with maximum efficiency at 26 in., and which will give, say, at this vacuum an efficiency of 65 per cent, if this machine were run at 28 in. the velocity ratio throughout the nozzles or blading would be changed and the efficiency at 28 in. would be considerably less than 65 per cent.

Again, take the case of a machine designed for 28 in. vacuum, the improvement from 27 in. to 28 in. will naturally be more marked than in the previous case. To illustrate what this means, let us take the simple example of the design of the low-pressure end of a Parsons turbine illustrated diagrammatically in Fig. 4.

With impulse turbines (in particular the smaller sizes), the commercial element naturally enters largely into the calculations. In turbines of the DeLaval type, the blade height must bear a certain relation to the diameter or width of the nozzle outlet. In turbines of the Terry type, the width of wheel must bear a certain relation to the nozzle outlet. As this commercial element bears such an important part in the design of small turbines where machines of this size are sold more on first cost than economy, it will be clearly seen that the highest efficiency cannot always be aimed for in this case. Whether the saving be 1 per cent or 6 per cent between 28 in. and 29 in. is often, therefore, of little importance, and certainly not of enough importance to warrant the material increase in the cost of the machine that would be necessary to obtain efficiently the advantage of the extra inch of vacuum.

It must also be borne in mind that the vacuum correction at full load in per cent is not a constant quantity for all loads. This factor will generally be found to be a fixed quantity of total steam per hour ranging over the whole load as shown by tests on a 9000-kw. machine, Fig. 5.

As there is no hard and fast law for vacuum correction covering all machines, where the contract vacuum is not obtainable and an accurate correction factor is desired, tests should be run at a series of vacua less than the highest obtainable and a curve plotted as shown in Fig. 6. With carefully conducted tests, the curve will be found to be very regular and have some unmistakable characteristic, leaving little or no doubt as to the path of the continuation of the curve.

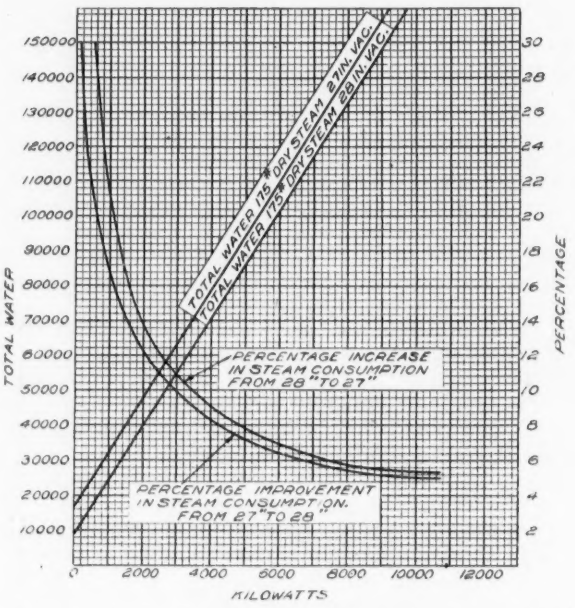


FIG. 5. EFFECTS OF INCREASING VACUUM ON STEAM CONSUMPTION OF A 9000-KW. TURBINE

While sufficient is known about the design and characteristics of steam turbines and what will be expected of them on test, it is still a physical impossibility to obtain absolutely on test the figures that are guaranteed. The manufacturer invariably figures safely and knows that at a certain full load rating he will obtain about a certain figure, and nowadays he cannot afford to miss this guess very much; but when it comes to guarantees based on all sorts of loads, varying as they do in many contracts from no load to 50 per cent overload, it is too much to expect that the characteristic of the machine will fall absolutely in line with the original calculations.

The practical or commercial view point should always be taken, therefore, in making tests of this nature.

It is necessary nowadays to figure very closely and an order is often placed on a guarantee that is no more than 1 or 2 per cent better than the next man's. In making tests it sometimes happens, therefore, that while the guarantees are easily met at some points they are a little bit over the guarantee at others. The writer

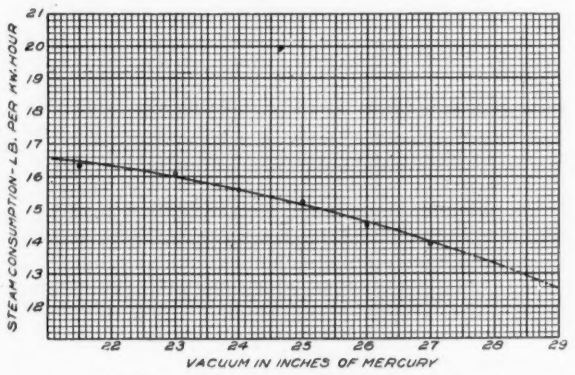


FIG. 6. VACUUM CORRECTION TEST CURVE

knows of cases where one point in the curves having fallen above the guarantee has been established as an argument for rejection. Figure 7 gives the complete curves of 2 machines that were supplied on a certain contract. The guaranteed curve is also given, and while in only one point did the machine exceed its guarantee, the machines were not considered by the so-called expert who tested them to be in accordance with the contract and he recommended them for rejection. The argument was so absurd that it was suggested by the manufacturer that an outside expert be consulted as to whether the machines did or did not meet their guarantees. Whether or not this inspector went so far as to obtain this advice, the writer does not know; but, the machines were

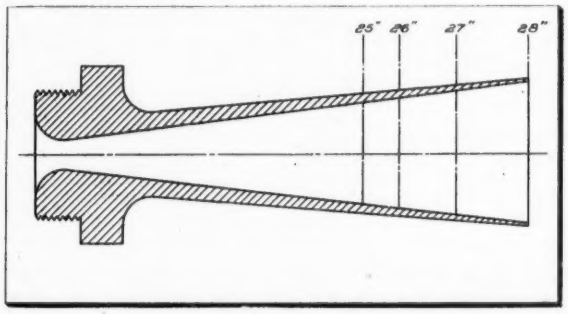


FIG. 8. CROSS-SECTION OF NOZZLE CORRECTLY DESIGNED FOR VARIOUS VACUA, ILLUSTRATING THE COMMERCIAL OBSTACLES TO IDEAL CONDITIONS

accepted. The absurd part of this whole controversy rested in the fact that in operation these machines were going to run for the majority of the time at a load ranging between ¾ and ½ rated load, and the tests actually show that the manufacturer was saving the customer a considerable amount of money by bettering the steam consumption at these points; but even this did not convince the inspecting engineer that the machines were what they were represented. This point has been enlarged upon to show how utterly absurd it is for purchasers to entrust testing and acceptance of their equipment to people whose education and experience is such that to them what a contract *says* is what it means, and who cannot take the meaning in the true engineering sense.

Some time ago the writer published some curves intended for use as a rough and easy method of determining the sizes of steam and exhaust pipes. They were based on many years of experience and the whole calculations were given showing the constants that were used. These curves were criticised because he had not made the formula more elaborate, incorporating more varying conditions. The writer's reply was that, while he knew

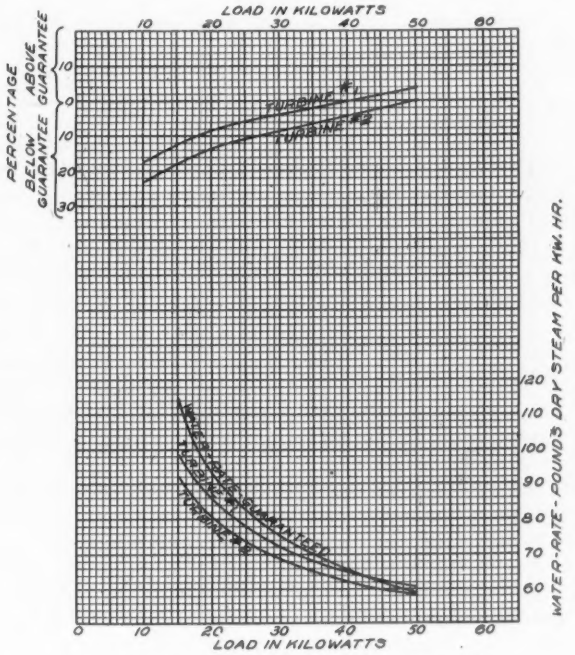


FIG. 7. TEST CURVES OF 2 SMALL TURBINES

they were obviously not correct for all conditions, he maintained that any piping design for any given condition only operated under that condition for a very short period of the total operating time. This is exactly a parallel condition with the testing of a steam turbine. The customer is interested in the general overall operation of his machine. He is interested in the general consistency of his water rates over a large range of load; but to state that he is interested in a water rate of 15,755 lb. with a load of exactly 3000 kw., is obviously absurd.

CONTRACTS FOR the 3 mill buildings, stair tower and power house, which E. & Z Van Raalte of Paterson, N. J., are building, were filed with the county clerk recently. The architect is William Wallace Christie. The contracts show an expenditure of more than $75,000. They have been awarded as follows: Carpenter work, P. S. Van Kirk, $12,100; iron, Joseph Sharpe Construction Co., $40,300; mason work, J. H. Steele & Son, $23,841.

Report Forms

DATA ON THE OPERATION OF ICE AND REFRIGERATING MACHINES. BY C. E. ANDERSON

A REPRODUCTION of an ice machine log sheet that might be of interest to some readers is shown in Fig. 1. I have always been an ardent advocate of keeping power plant performance records, if only for my own satisfaction. By means of records I could compare one day's run or performance with another, in this way I could see if any changes I happened to make about the plant, increased the economy in any way.

The sheet outlined here I used for a gas engine driven ice machine of 60 tons refrigerating capacity, in a large hotel. The auxiliaries, such as condenser pump and brine circulating pumps, were driven by motors. The current for the motors as well as for lighting purposes was purchased from an outside concern.

As I did not know what was paid for gas, electricity and water I did not fill this item out in the total cost for the week. The ice machine was run during the day and shut down at night. The brine pump was run 24 hr. a day. The water after leaving the double pipe ammonia condenser was discharged into a tank where the different house pumps drew their supply of water for the different uses about the hotel.

No. 1 cooler was used for perishable stuffs while the No. 2 cooler or freezer was used for keeping meats and fish, also game of one kind and another. No. 3 cooler was used for apples and vegetables, wines and liquors of different kinds.

The gas engine was connected to the ammonia compressor by means of a clutch and shaft.

Temperatures of the different coolers and condensing water, also inside and outside temperatures, were taken at 9 a.m., 12 m. and 3 p.m., while the wattmeter and gas meter and water meter readings were taken at 7 a.m. each morning.

Form C 8757

SWIFT & COMPANY

Engineer's Daily Report

Date 7-25 1913

House 1004

Engineer John Doe

Started Engine at 6 A. M. Shut down

After No. 6 boiler was washed with 160 lbs. pressure, I got into the boiler and tested all the stay bolts with light hammer and examined the seams or grooving and the plates for internal corrosion; also examined front and back tubes, sheets and tubes, and report everything in first-class order. Thickness of scale on tubes 1/16 "on shell 1/8 " Examined safety valve and find that it pops at 149 and returns to its seat at 146 lb. pressure without leaking. I find the glands of all valves of steam piping tight and all joints free from leaks.

I examined all the header supports and report them tight. Injector was working -1- hours today and is all right. Steam pump O. K. Fire pump O. K. ~~Engine O.K.~~ Fire door liners and all brick work O. K. Extension sheets tight. Combination valves and pipes working freely.

The Following Repairs Need Attention:

Engine # 2 H.P. piston needs to be repacked.
Gasket between frame and cylinder leaking needs renewal

NOTE—Draw a line through all of the above reports you have not examined. Also draw a line through any part of the printed report that upon examination you find different, and report in writing the actual condition, in the space below the printed report allowed for this.

FIG. 2. ENGINEER'S DAILY REPORT ON BOILER CONDITION

Two forms, as used by Swift & Co., are shown in Figs. 2 and 3. These forms are filled out every 24 hr. The daily report gives data on how many hours the engines have run and the conditions of boilers, engines, pumps and injectors.

LOG OF ICE MACHINE NO. 1 WEEK ENDING June 17 1913

DAY OF WEEK	TIME START	TIME STOP	METER READINGS: WATER START	WATER STOP	WATTMETER START	WATTMETER STOP	GAS START	GAS STOP	OIL USED: ICE MACH. CYL. OIL	ICE MACH. ENG. OIL	MOTOR	WASTE	PACKING	AMMONIA PUT IN SYSTEM: NO. OF DRUMS	GROSS WT.	WT. OF DRUMS	NET WT.	OIL DRAWN FR. REC.	SALT PUT IN SYSTEM
SUNDAY	7 a.m.	7 p.m.	216800	265400	117000	135000	6100	12580	1 gal.	1 gal.	1 gal.	3 lbs.	—	1	350	200	150	1 gal.	700 lbs.
MONDAY	6 a.m.	9 p.m.	265400	296400	135000	165000	12580	23380	—	1 gal.	—	"	3 lbs.	—	—	—	—	1 gal.	—
TUESDAY	6 a.m.	8 p.m.	296400	322000	165000	193000	23380	33460	1 gal.	"	—	"	"	—	—	—	—	1 gal.	—
WEDNESDAY	6 a.m.	7 p.m.	322000	392200	193000	219000	33460	42820	1 gal.	"	—	"	"	—	—	—	—	—	—
THURSDAY	5 a.m.	9 p.m.	392200	478600	219000	251000	42820	54340	1 gal.	"	—	"	"	—	—	—	—	—	—
FRIDAY	6 a.m.	8 p.m.	478600	554200	251000	279000	54340	64420	1 gal.	"	—	"	"	—	—	—	—	1 gal.	—
SATURDAY	5 a.m.	6 p.m.	554200	624400	279000	305000	64420	73780	1 gal.	"	—	"	"	—	—	—	—	—	—

	AMMONIA PRES. BACK PRES.	AMMONIA PRES. COND. PRES.	R.P.M.	TEMPERATURES: COOLERS NO. 1	COOLERS NO. 2	COOLERS NO. 3	AIR INSIDE	AIR OUTSIDE	COND. WATER IN.	COND. WATER OUT	DETAILED REMARKS: CONDITION OF MACHINE	CONDITION OF COILS	CONDITION OF COOLERS	REPAIRS
SUNDAY	18	165	62	32	14	42	76	66	54	64				
"	16	160	60	"	"	"	78	68	"	62	O. K.	O. K.	Good	
"	14	162	58	30	"	"	80	68	"	60				
MONDAY	17	160	62	31	13	"	74	65	"	63				
"	14	164	60	30	"	"	76	66	"	62	Left hand stuffing box leaking	O. K.	"	Packed left hand stuffing box on ammonia compressor. O. K.
"	12	160	58	29	13	"	78	64	"	60				
TUESDAY	17	168	64	31	13	41	70	60	"	63				
"	14	166	62	30	"	"	72	62	"	60	Discharge valve Left Cyl. Leaking	O. K.	"	Renewed discharge valve gasket on left cyl. ammonia compressor
"	12	160	58	28	12	"	74	60	"	60				
WEDNESDAY	18	166	62	34	13	42	72	58	"	64				
"	15	164	60	32	14	·	70	54	"	63	O. K.	O. K.	2 top coils on #3 cooler melted off	Removed 2 top brine coils on #3 cooler. Plugged up on return bend O. K.
"	13	164	58	30	12	43	72	58	"	62				
THURSDAY	16	168	60	32	13	"	70	52	"	64				
"	14	166	58	30	12	"	72	54	"	63	O. K.	O. K.	Good	
"	12	160	54	28	11	42	74	50	"	60				
FRIDAY	18	170	64	34	14	"	70	40	"	66				
"	16	168	62	32	13	"	"	42	"	64	Loose brasses Right Cross-head	O. K.	"	Adjusted cross-head brasses on right side ammonia compressor
"	14	165	60	29	12	"	72	40	"	60				
SATURDAY	16	166	62	32	13	41	74	56	"	63				
"	14	163	60	30	12	"	76	58	"	62	O. K.	O. K.	"	
"	12	160	54	28	11	42	78	50	"	60				

WEEKLY TOTAL		COST
TOTAL WAGES	2 Eng.	$55.00
" REPAIRS		7.00
" HOURS RUN	94	
" KW. HOURS	188	
" CU. FT. GAS	67680	
" GAL. COND. WATER	507600	
" GAL. OIL	8	2.68
	TOTAL COST	

SIGNED _____ ENGINEER

FIG. 1. LOG OF ICE MACHINE DRIVEN BY A GAS ENGINE

The refrigerating machine report, Fig. 3, gives the temperature of the feed on the 2 brine lines and the temperature of the returns to the refrigerating tanks or

Swift & Company

Report of Refrigerating Machines #2 1609 House 7/27 1913

TIME	Temperature of Feed No. 1	Temperature of Feed No. 2	Temperature of Ret. No. 1	Temperature of Ret. No. 2	Suction	Press	Cond. Pres	No. 1 Ice Mach. R.P.M.	No. 2 Ice Mach. R.P.M.	No. 3 Ice Mach. R.P.M.	No. 4 Ice Mach. R.P.M.	Room Pressure	Vacuum	TONNAGE
1 a m	10	10	14	15	15	-	180	60	—			145	24	400
2 a m	"	"	"	"	"	-	"	"	—			"	"	"
3 a m	"	"	"	"	"	-	"	"	—			"	"	"
10 a m	11	"	"	"	17	-	"	"	—			"	"	"
11 a m	"	11	15	"	"	-	"	62	—			"	"	420
12 noon	"	"	"	"	"	17	190	"	50			143	23	520
1 p m	"	"	"	"	"	"	"	"	"			"	"	"
2 p m	"	"	"	"	"	"	"	"	"			"	"	"
3 p m	"	"	"	16	"	"	"	"	"			"	"	"
4 p m	12	12	"	"	19	18	"	"	"			"	"	"
5 p m	"	"	"	"	"	"	"	"	"			"	"	"
6 p m	"	"	"	"	"	"	"	"	"			"	"	"
7 p m	"	"	"	"	"	"	"	60	"			"	"	500
8 p m	13	13	"	"	20	20	"	"	"			145	24	"
9 p m	"	"	16	"	"	18	185	"	48			"	"	480
10 p m	"	"	"	"	"	"	"	"	"			"	"	"
11 p m	"	"	"	15	"	"	"	56	"			"	"	440
12 p m	14	"	17	"	21	"	"	"	"			"	"	"
1 a m	"	"	"	"	"	-	180	"	—			"	"	360
2 a m	"	"	"	14	"	-	"	"	-			"	"	"
3 a m	15	"	18	"	"	-	"	"	—			"	"	"
4 a m	14	"	"	"	20	-	175	54	—			"	"	340
9 a m	13	"	16	13	18	-	"	"	—			"	"	"
8 a m	12	12	14	"	16	-	"	"	—			"	"	"
Avg								57.8	49.3			144	23.9	441.6

FIG. 3. REPORT ON REFRIGERATING MACHINE

brine tanks. The suction and condenser pressure is also given and the revolutions of the different machines, also steam pressure, vacuum and the refrigerating tonnage.

Four-Valve Engines

By Bruce H. Tingley

THE article in the December 15 issue of Practical Engineer, by A. M. Morse, in defense of the Corliss engine, tends to depreciate the value of the nonreleasing Corliss or 4-valve type of engine. It can be shown, however, that the 4-valve engine possesses advantages over the releasing type which are highly valuable.

The advantage of the releasing type as pointed out by Mr. Morse is the quick closing of the admission valves. Now, many 4-valve engines have been built that will show nearly as sharp a cutoff on the indicator card as the releasing type at the same speed. It is doubtful whether this advantage will show much economy at speeds above 150 r.p.m. Of course, the releasing type is no doubt better adapted to engines of more than 1000 hp., where the shaft governor would be too large to handle to the best advantage and where the speed is below 150 r.p.m.

The type of governor which has to be used with the releasing type has some disadvantages which are overcome with the shaft governor. When using the simple pendulum governor, the engine must show an appreciable decrease in speed in order to compel the governor to act, as the weights have to change position which can only be accomplished by a reduction in speed. For a given change in speed, the change in the position of the weights is relatively very small and the relative change decreases rapidly as the speed of the governor increases. It is evident, then, that this type of governor is impractical at high speeds. If the weighted pendulum governor is used to increase the sensitiveness, the effect of inertia is felt which tends to carry the weights beyond the desired point in changing position, which will cause racing of the engine.

The shaft governor does away with these disadvantages of the pendulum governor and also has advantages of its own. In using the simple inertia governor, perfect regulation is obtained and may be adjusted to governor within a limit of one revolution. A regulation of 2 per cent is the common practice with the inertia governor, the engine returning to normal speed in from 2 to 4 revolutions. The shaft governor has the advantage in that it may be made to speed the engine under load or, if the case calls for it, the speed may be made to decrease under load; while in regard to lead, the shaft governor provides a wide latitude, the results of which are entirely in the hands of the designer.

The 4-valve engine is not burdened with the extra amount of valve gear of which the vacuum pots are no small item. Vacuum or dashpots, in order to perform their function, must be kept in perfect order, and at their best cause more or less trouble.

The question is, why shouldn't a builder use 4 valves, to take advantage of better steam distribution by using 2 eccentrics, and to obtain a perfect degree of regulation by the shaft governor? It is as Mr. Morse states, the survival of the fittest will eliminate the undesirable type, but it is evident that the 4-valve engine is finding favor more and more as time passes. It is doubtful if the 4-valve engine will be eliminated, however, and the releasing type will surely be used where it is more desirable.

To sum up, why burden an engine of from 100 to 1000 hp. with a speed of from 150 to 200 r.p.m. with the extra amount of troublesome releasing valve gear when as great efficiency can be shown with the simpler type?

It is a mystery where Henry Ford, selling his automobiles at the low price asked for them, gets all the money that he seems to be "itching" to dispose of. On top of his plan to increase expenses some $10,000,000 a year by what seems, from an outsider's viewpoint, an unwise as well as unjustified increase in payroll, comes the announcement that plans are to be let for a $1,000,000 power plant, to have three 7000-hp. gas engines driving electric generators, and the heat from jacket water and exhaust to be used to make steam for operating a 7000-hp. steam engine.

The newspaper reporter evidently has his figures slightly twisted. Having got the habit of talking of millions in regard to the Ford enterprises, he has continued it, regardless of probabilities. The press statement is, $1,000,000 will be the cost of the power plant, that the 4 new engines will cost $6,000,000, and beyond that, that the power building will cost $150,000, which seems to indicate that figures have gone to the reporter's head.

Factory Organization and Administration *

CHOICE OF LOCATION WITH RESPECT TO LABOR, MATERIALS, POWER AND MARKETS. THE ORGANIZATION AND THE MANAGER. BY W. L. SAUNDERS

EDUCATION, in times past, was not supposed to concern itself with the practical everyday affairs of business, but was rather looked upon as a means of refinement, an artistic training school. Today, those of us who have been active in the battles of life, whether as professional or as business men, or as both, know that there is no more useful foundation stone in our educational structure than that which upholds the principles that govern our industrial life. Education for the purpose of mental training belongs only to the period of youth, and its value cannot be overestimated, but the maturer mind is best equipped to meet the problems of life when it has been taught to think about and to retain the practical lessons of industry.

This afternoon we are expected to survey, in a general way, the problems which a factory executive meets, such as the choice of location and site, lay-out and construction of buildings, the type of organization and the handling of men and materials.

There is no rule of 3 governing any of these subjects, nor is it reasonable to lay down a set of rules which may be adopted as fundamental, governing all kinds of manufactures. There are, however, certain principles which experience has shown to be correct, and which, in a general way, might be accepted, or, at least, carefully considered before definite action is taken. For instance, in considering the choice of location for a manufacturing plant, the questions of labor, materials, power and transportation are of paramount importance. It is sometimes of equal importance to consider markets.

CHOICE OF LOCATION

TAKING ONE consideration with another, the nature of the industry determines which element is predominant. A paper mill or a carbide factory should give first consideration to the question of power, because this item is usually from 50 to 80 per cent of the cost of the product. This is why paper mills are located where waterpowers are available, and as paper mills require wood pulp for the raw material, this can usually be supplied at the least expense along a river course, where we have the power and raw material factors controlling. Paper is made by machinery and the number of laborers employed, when rated in dollars and cents, in proportion to these other factors, is not a serious item when considering location. Furthermore, there is a certain amount of steadiness about the work of a paper mill. It is not subject to the violent fluctuations that occur in general manufacture. Such fluctuations affect the question of the volume of labor employed and make it important to consider the labor market in the neighborhood.

Cement factories locate where the clay and other raw materials are plentiful—in fact, one seldom sees a cement works located anywhere except over a clay deposit. It is of the greatest importance, however, in the cement industry to obtain cheap power, because cement is now made by machinery and this is one of the reasons why the cement industry in New Jersey and Pennsylvania has flourished and increased to so large an extent.

In textile manufacturing, and in the machinery line, labor and transportation are controlling factors. The relative importance, however, of the labor to other items which go into the cost sheet, varies with each class of manufacture. There is also the broad problem of business policy to be considered, but in a general way in textile and machine manufacture, labor controls the situation. The class of labor is a subdivision of great importance. It is a fatal mistake to locate a factory in which skilled labor is to be employed, such, for instance, as for the making of typewriters, in a locality noted only for its large supply of common labor. New England is a choice field for typewriter factories, and is preferable to Birmingham, Alabama, although in the latter place labor is more plentiful.

In textile work it has been shown by statistics that the cheap, common labor of the South does not compare favorably in cost with the more expensive skilled labor of New England. If this were not so we might reasonably expect that all cotton factories would be located in the South, where the raw material grows. There are but few lines of manufacture in America, where it may be said that cheap labor means low cost. The contrary is usually true, for where skilled labor is employed the unit cost of product is less than in places where cheap, unskilled labor is used to do the same kind of work. This, in itself, is a broad subject and I shall not discuss it in detail, except to call your attention to the fact that in that part of the world where labor is cheapest—namely, China, Japan and India, manufacturing does not prosper. The Japanese, with all their enterprise and skill, have been unable to compete with England, Germany or America in the manufacture of steel products, although the actual cost of labor in the steel works of Japan is ⅛ that in the United States.

In considering the item of transportation, it naturally follows that waterways adjacent to the works afford economical transportation advantages. The importance of this item is increased as the weight of the product increases. That is, the heavier the material manufactured, the more important becomes the consideration of cheap transportation. Pig iron can be delivered more cheaply by water than by any other means, yet pig iron is not usually made at or near rivers and harbors because consideration must be given to the raw material, and to the markets for the product. If the consumption of pig iron is mainly or wholly in the interior, it might pay to locate the furnace somewhat near the area of consumption, provided raw material is available; even where this is not at hand, it may pay to transport the raw material by freight, paying for a long haul, as long as the point of delivery of the pig is in the neighborhood.

*From an address delivered before the Graduate School of Business Administration, Harvard University.

An illustration of the controlling influence of transportation may be given in marble, granite and other stone works where the material is heavy. It may cost more to freight a block of stone than to quarry it, and where quarries are located near tide-water it is a great advantage to the business from an economical standpoint. In the case of the stone industry, however, and, in fact, in any industry producing a heavy product, a tide-water advantage in location of the factory may be entirely counteracted, unless there is a market for the product close to tide-water. The great marble quarries of Carrara are situated so near tide-water that this material is loaded upon ships and transferred to the markets of of the world, competing in cost of delivery, in the United States, for instance, with material quarried inland, which must be transported by rail. The wealth of England has been largely built up through her coal mines, which are located in the south, and so close to tide-water that this product has been, and still is, shipped to all parts of the world in competition with home industries that are not so favorably situated. It has been said that the reason why America does not supply the world with coal is because her mines are so far from the seaboard.

City or Country

Having determined the general geographical locality for an industrial plant, the question arises as to whether it is best to establish the business in or near large centers of population or remote from such centers in a rural district. On this point experts differ materially, and before giving the pros and cons it is best to eliminate certain industries which belong to a class all by themselves—an industry, for instance, which employs so high a grade of laborers that they may be called artists in their line, such, for instance, as engravers and silverware workers. In such lines the country seems best suited because the trained workmen are likely to establish themselves with homes and to be free from the tempting environments of a large city.

There are also some who advocate a country shop in cases where a large volume of untrained common labor is employed, the argument being that an untrained country boy makes a better workman than a lad from the city. It is true that the best common labor is found in the country. This is because the life and training of young men in the country is more conducive to good habits. The habit of work becomes established and the grade of character is usually higher. This, however, hardly offsets certain disadvantages. In the first place, the volume of common laborers in an isolated place must necessarily be small. There is only a limited supply to draw from and when this has been exhausted it becomes necessary to import workmen. This is frequently done by bringing Italians, Slavs and other foreign laborers, to the plant, and here we reach a condition where the labor becomes most uncertain, because these foreigners establish themselves only for the purpose of making money and not to live and move and have their being. An industry, therefore, which is likely to call for large supplies of common labor, and which may be more or less uncertain in its demand, is likely to be handicapped if located in the country.

Among the errors often committed in locating works in the country, is that of locating near a large city, without being actually on its border or in its suburbs. In the vicinity of New York, for instance, there are many communities where men commute, going back and forth to the city each day. Where works are located within commuting distance from New York it is difficult to get workmen to move from the city permanently to the country, because they are city men. They like the city life, have been accustomed to it and are unhappy if transferred. Furthermore, wages in the city are usually higher than in the country. Now, in order to recruit a working force, the supply in the suburban city is drawn upon and it is found difficult to get young men because your men prefer to take positions in the large city, going back and forth each day. They will do this even at lower compensation. The city acts like a magnet to absorb young people who might otherwise render valuable service at the works.

A works management that does not give due consideration to the value of young men is an incompetent management. It is from the youthful energy of the beginner that much productive work is obtained, and if young men cannot be had, old men are employed at a disadvantage to the cost sheet. The importance of this can hardly be overestimated, because it is a well known fact that older men seek the country, while younger men seek the cities.

I should say, therefore, that in artistic specialties and where the works are of moderate size, a country site is best, but in practically all other lines the points of advantage seem to be with cities. This does not mean location directly in a large city, but on its border, somewhere within carfare distance and directly in it, provided, of course, that the problem does not become one of expense of real estate or means of transportation of product.

Few, if any, manufacturing lines are absolutely stable in their output; that is, manufacturing is an uncertain business, subject to fluctuations produced by general conditions that are beyond control. Mr. Carnegie has said that the steel business is a feast or a famine, and this applies to a smaller extent, perhaps, to almost every line of manufacture. There are busy times and there are dull times. During busy times we want plenty of men, and are increasing our force, during dull times we are laying them off, and here is where the advantage of a city is most marked. Having a large supply of labor, whether skilled or unskilled, we are able to draw upon this supply in times of activity, and in dull times we may lay men off without compunction, because they seek work elsewhere in the same community, and many of them come back, if they are wanted, when times are good. To be confronted with a declining market in a country location means that we must lay off men, some of whom may have been with the works for a long time. These men may have their homes there; but, as they must live, they migrate to some other town and are lost permanently. The alternative is that they remain around the place in poverty and distress.

In large centers of population there are usually other lines of manufacture where the boys and girls of the workmen may be employed, such, for instance, as silk mills, stocking factories, organ factories, etc. This is an important consideration in locating works. A me-

chanic, for instance, usually gives his boys and girls a public school education. After that they must seek employment. If they cannot get it in the neighborhood, they go away from home, to some large city usually, and this is likely to result in drawing the parents away, perhaps at the very time when they are most needed, and perhaps permanently.

Such exceptions as Gary, Illinois, cannot be used as an argument against the proposition. The Steel Corporation is so big and its works at Gary have been established on so large a scale, that they can afford to go out in the woods, establish works and build up a city. This has been done at Gary, which can hardly be called a country town. Besides the governing condition, there were transportation facilities on the Great Lakes. The iron ore is brought down from the Mesaba Range by water, is converted into steel and is transported by water to large markets.

Another exception, for instance, is that of Pullman, Illinois; and here let me say that, if it is the purpose of those locating works to speculate in real estate, a country site is likely to be most attractive. Pullman, Illinois, is, however, an example of the folly of attempting to run a manufacturing plant properly and at the same time to speculate in real estate. The 2 do not go together, and while there may be a temporary period of activity and profit, there is likely to be a day of reckoning, because the one most important factor which makes for permanent success in handling men is to establish among them a feeling of absolute confidence. If they feel that they are being used to promote a land enterprise, or if their homes either belong to the company or are taxed by the company, or if they are expected to purchase them through the company, a feeling is engendered which does not make for efficiency and success. The great strike at Pullman, Illinois, has, I think, settled this question.

In these general thoughts I do not refer to "cities" as very large communities particularly, but as places where some 25,000 or more people live, where there are amusements for the workmen, where railway and other transportation facilities are available, and where land is plentiful.

There is no greater mistake made in locating works than to begin on a small area that is hemmed in and which does not afford opportunities for expansion. No one can tell what the future may bring forth in a manufacturing business in America. I have seen works expand against great obstacles, such as hills and rivers in the immediate neighborhood, or against expensive land or buildings which must be acquired in order to provide facilities for taking care of the product. I have known this to become so acute that it was found best to abandon the site entirely and locate where there was more room. It is a good rule to follow, to build with care, providing only for the immediate needs of the business, but let that building be located on property which affords ample room for growth. Small buildings and plenty of land are the best beginning. There is a further economic reason for this in that, wherever works are located, property increases in value in the vicinity. This has a far-reaching effect in many lines of manufacture, and the concern that makes this possible should have land enough for its own future needs to warrant the investment of its capital.

Reference has been made to the advantages that are to be derived by locating at tide-water. There are many lines of manufacture where these advantages are not paramount, as, for instance, in textile work, or in light machinery manufacturing, such as typewriters, pneumatic tools, etc. It is of the greatest importance, however, to have more than one means of transportation. Two or more railroads passing the premises safeguard the interests of the manufacturer. It is true, of course, that rates are fixed and definite; but no one knows how permanent this fixture is, and even where rates are equal, accommodations such as supply of cars, are always of great importance. All manufacturing requires incoming and outgoing material, and serious losses arise where the transportation of this material is not done in order and with expedition.

Finally, in locating works, as in locating a home, look well to the sources of wholesome water. There should be plenty of good water to drink and a double source of supply for fire protection. It pays to have ample water supplies for fire protection because it means reduced insurance rates and safety against total destruction.

Layout and Construction of Buildings

Having selected a site, the next question of great importance is the layout and construction of buildings. Each line of work calls for such a layout of buildings as will best suit its product. In textile work, for instance, buildings arranged in blocks, many stories high, are economically correct, while in the heavy machinery line a ground floor shop is best. A foundry should all be on one floor, except where space is a controlling consideration, when the small core work might be done in galleries.

Earnest consideration should be given by the builder to the question of fire protection. The day of wooden shops is over, because of the burden of insurance and the danger arising from a possible paralysis in business. Nowadays fire rates are brought down to a negligible figure by properly designing the works. Formerly, it was supposed that buildings should be detached one from the other so as to prevent the possibility of total loss, but with the modern steel and concrete structure this is not necessary. In pattern shops and other places where there is inflammable material in storage or in process of manufacture, even though the building be absolutely fireproof, it is best to provide sprinklers, because, should a fire occur, the sprinklers confine the flames to a limited section, and thus save property and perhaps life; but in general machinery manufacture sprinklers are not so necessary if the buildings are properly constructed.

Saw-tooth construction still holds supremacy for works built all on one floor. This saw-tooth construction comprises a series of gables arranged like the teeth of a saw, the glass in the gable facing the north and thus giving plenty of light without sun. This construction is in the main a series of steel or iron posts spanned by trusses and so arranged that extension in any direc-

tion is easily effected. The cost of a saw-tooth building is low when compared with any other type of building. Complete with cement flooring and roof it is about $1 per sq. ft.

The saw-tooth building has the disadvantage of not affording means for transportation of material by overhead cranes, so that it is used mainly where the product is light enough to be transferred by trucks.

The multiple-story concrete building is a modern design, which in some cases replaces the saw-tooth construction. This multiple-story building is practically concrete cast over steel frames. The entire wall surface for each floor above a point some 4 or 5 ft. from the floor line is glass, and all the rest of it, including floors and ceilings, is concrete or brick. This building is a monument, indestructible by fire, with plenty of light, and its cost per square foot of floor area is less even than that of the saw-tooth construction. Such a building is suitable for light manufacture where certain operations are performed on each floor. Freight elevators are provided for transporting the material from one floor to another. This construction, of course, occupies less space than the saw-tooth type, and the only prominent disadvantage is that, if it becomes desirable to increase the space for turning out the product of one floor only, it will be necessary to extend all of the floors simultaneously.

Type of Organization

In manufacturing, organization is of paramount importance. Success or failure depends upon organization, and the first in importance is the manager. His first, and the governing consideration, is handling of men. This is the hall mark of the successful manager; all else is secondary in importance. The manager who knows how to handle men knows how to organize the works for the best results. He is the court of last resort, he must be the one to say "Yes" or "No" in the works, and without such a man success in a plant is always jeopardized.

The successful manager provides a superintendent under him who handles the foreman of each department, or in some large works the manager provides a superintendent for each department, each superintendent reporting to him and the foremen reporting to the superintendents. The extent or size of the works governs conditions of this kind, but the qualities that make for success in a manager are executive ability and a capacity to inspire confidence in his organization. He must be in touch with his official family, that official family meaning all the superintendents, heads of departments and clerks, even in some cases going down to the errand boys. He need not be in touch with the individual, but he should know his boss. Regular meetings for association of ideas between the manager and his official family will mean the efficiency and success of the organization. I have known of cases where 2 or 3 superintendents of different departments, all of them good men, yet jealous of each other, disliking each other, not associating with each other at home, were brought to a condition of friendship and co-operation by meeting daily at lunch with the manager and sitting at the same table with him.

I cannot agree that the successful plant manager must know that his sales department is being handled properly. In fact, I have never seen any advantage derived from having the sales department or the executive force of a company located directly at the works. The manager's business is to turn out the product expeditiously and efficiently. If his time is occupied daily reporting to the president or other officials of the organization, discussing questions with them, he cannot be directing the works. His best work is done where he is isolated, reporting personally weekly or monthly, but being all the time on his job and knowing that he has the confidence of the officials and of the men. Human nature is a governing force among working men. If they are treated well and have confidence in their boss they will do their best work. The inspiration of confidence must come from the manager, his character is stamped upon the entire organization.

Handling of Men and Materials

The true way to handle men is to treat them as if they were men and not as servants. A wise manager rewards good men and gets rid of bad ones. He is not there to conduct a training school in character. He takes men as they are and expects them to do the work that is put before them and to do it well. If they are incompetent and do not, after a reasonable time, improve, he is handicapping his organization by keeping them. If they are immoral, and by this I mean if they do not tell the truth, or if their habits are such that they lose time and work, he must get rid of them, even if it be only for the purpose of creating an example.

Above all things a manager should avoid patronizing his men. Anything that is obtained for nothing is usually not appreciated and is seldom worth having. Working men are usually intelligent beings who expect to receive a fair consideration for their labor. They do not ask for nor desire favors. A plant under the influence of paternalism is not in a condition of a permanent prosperity or efficiency. Welfare work, while wholesome and proper when done in a practical way, is injurious if overdone. This means that it is the duty of employers to provide conditions of comfort and safety for the men while at work. It pays to have the works clean and to have the best sanitary arrangements; to see that good air and water are available, that safety devices against injury are thoroughly installed, that immediate service is provided for the sick and injured, and that recreation and exercise are encouraged during vacation hours. When welfare work is misapplied it extends to giving food to the men free of charge, giving free tickets to entertainments and the like. Men want a fair wage and with it they prefer to buy their own food and theater tickets.

An excellent illustration of practical welfare work is in the Benefit Society, which has been established through so many organizations. In this society the men control the board of directors and the company contributes a sum of money equal or greater than that contributed by the men. This Benefit Society takes care of the sick and injured and provides a substantial fund to the family of one killed at the works. Here is a spirit of co-operation between the employer and the employed, which is far reaching in its effects throughout

the organization. Such a system will not be a success unless the employer takes a liberal view of the situation. He must contribute liberally and he must recognize the right of the employes to run the society.

In handling materials in a shop it may be said, in a general way, that railway tracks should be provided only where the material is transported regularly and in volume from one definite point to another. If this is not the case, that is, if the material when partly finished is to be carried to another part of the shop, and so on, then the traveling crane can best serve the purpose of transportation. Traveling cranes for heavy product are of great advantage in making for efficiency. It is a common mistake to economize, especially in foundries, by putting in a few cranes only, where money might be saved by multiplying the number, even though some of them are idle most of the time. It does not pay to have a gang of men waiting for a crane; it should be there when it is needed. The expense in interest on the investment is negligible compared with the time lost and increased cost of the product that results.

In large floor areas of the saw-tooth construction, or in cases where traveling cranes are not available, the trucking system is used. There has recently been introduced a form of truck which is so simple and which effects such a great saving on the floor that I shall call attention to it. At each machine tool a simple wooden platform is provided, on which the product that is to be carried away is laid. Several of these platforms may be around the same tool. A man goes about the works with a truck, which is so constructed that it is run underneath those wooden platforms and, by a simple cam device, lifts the platform from the floor and carries it anywhere about the works, depositing it and drawing out the truck for another load. This not only saves the labor of picking material from the floor of the shop and loading it on the truck, but it saves time lost in waiting for a truck to come around. The platform is always there.

Finally, let me call attention to the danger of overcapitalizing. It is all very well at busy times to spend money on bricks and mortar—manufacturers recognize the danger of not being able to supply their customers, but times are not always good and at depression periods interest and depreciation eat up profits. It is not difficult for us to think of large manufacturing concerns that have been brought in to the condition of receivership by having shops that are too big an investment, so large that the auditor, in making out the balance sheet and figuring the interest and depreciation on the plant, finds that instead of a profit there is a loss. There is such a thing as having the plant too big, and in some lines it is best to stop after reaching a certain point of size and develop elsewhere, thus having 2 plants instead of one. A plant may be too big for a single organization to handle efficiently. A man can do but one thing at a time and do it well. His capacity to look about the works is limited. If he has too much territory to cover he does not cover it all properly. Competing plants are advantageous in other ways. Managers compete with each other to turn out a better product and at a lower cost. This is the best kind of competition, within one organization, a competition that is not destructive because the control is in the executive force of the company.

Cleaning Babcock & Wilcox Boilers

RAPID AND EFFICIENT METHODS OF CLEANING, INSPECTING AND REPAIRING BOILERS EXPLAINED; TOOLS AND DEVICES WHICH MAKE WORK EASIER. BY A. G. SOLOMON

BABCOCK and Wilcox boilers are in use in all parts of the country; in some places, where the water is exceptionally bad, the work of keeping these boilers clean is a big item. They must be cleaned and inspected at regular intervals and the length of time between the cleanings can only be determined by close observance of the conditions that exist.

In some plants once a month is none too often, while there are some boilers that will be in fine condition if given an internal cleaning twice or even once a year. I have used water that keeps the inside of tubes and drums as free from scale as a new stovepipe; in a case of that kind, the boilers are opened up only for inspection and the only cleaning they ever get is a change of water once a month.

No matter how good the water is, it will have to be changed once in a while or it will cause foaming and priming; in an ice plant I have noticed an improvement in the quality of the ice by frequently emptying the boilers and filling with fresh water. Using the blowoff often sometimes keeps the water from getting strong and soapy in places where large quantities of alkali are found in the water.

To clean a Babcock and Wilcox boiler of 400 hp. or over in a day of 12 hr. will require at least 6 men and they must know how to go at it if the work is to be properly done. The fire should be let die out about 9 o'clock at night and the blowoff valves opened at 4 o'clock in the morning. The main stop valve should be closed just as soon as the boiler quits making steam. Do not let a boiler cool down with the full pressure on it, as it puts an unnecessary strain on and causes unequal expansion owing to some parts cooling long before others. Neglect of this precaution, I believe to be the cause of leaky tubes and nipples and also cracked headers.

Starting at 6 o'clock, the work can be so arranged that each man of the boiler washing crew will have regular duties to perform. Two men can start taking off the hand-hole plates on the front end. One man can start cleaning the combustion chamber. One man can get in each drum and work at the scraping and chipping. It is best to keep at the removing of scale from the drums all day and if they cannot be gone over entirely in 12 hr. I have found the following plan to be very good.

Have the men begin at the front end and clean thoroughly as much as they have time for but not to skip around to different places. The next time that boiler is cleaned begin scaling the drums where the work ended before and in this way the drums will be kept fairly free from thick scale. If the drums are in bad condition it is best to use more men or else keep the boiler down longer.

Turbine Tube-Cleaners

This much of the work will take 5 men and the other one of the crew can see that the turbine tube cleaners are ready and the hose connected and the pump ready to start so that the cleaning of the tubes can commence as soon as the hand-hole plates are removed. In this connection, a few words about the care of the turbine cleaners are necessary. They wear and get out of proper working order the same as any other mechanical device.

After using, the turbine should be cleaned and then kept in a pail of oil till again needed. The main body should be calipered frequently, as its outside diameter decreases from wear and in time this will cause the cleaner to travel through the tube too fast to get the desired result. When this occurs a light cut can be taken in a lathe and a bushing of the required diameter

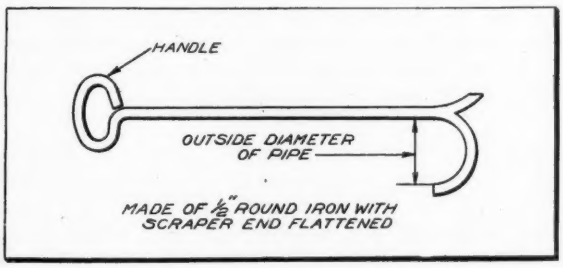


FIG. 1. SCRAPER FOR OUTSIDE OF TUBES

pressed on. The turbine should have only about 1/32 in. clearance in the tube.

Two men can work with the turbines at the same time; but they should never shut the water supply off at the same time, as a gasket might be blown out of the pump owing to the increased pressure. Quick opening lever valves should be placed within easy reach of each man. A relief valve of sufficient size should be on the pump discharge to relieve the pressure in case the turbines are shut off at the same time.

Cleaning the Plates

Now, one man can go to work on the cleaning of the plates and getting the nuts to run easily on the bolts. Some have the idea that the faced surfaces of the plates, nuts and headers should be cleaned with emery cloth fastened to a buffer; but I have seen much better results and fewer leaks where emery is not used at all. These joints are faced perfectly smooth and emery cloth scratches too much. A board sprinkled with fine brick dust will be found sufficient to rub the plates and nuts on, and the headers can be cleaned the same way by using a little oil so that the brick dust will stick to the board. If care is then taken in putting the plates on, there will be no trouble with leaks. Graphite and oil should be used on the faced surfaces and on the threads of the bolts.

If cast-iron headers are used, they should be closely examined for cracks while cleaning. The cracks nearly always begin at the edge of the hand-hole and can be seen quite easily.

Cleaning Furnace and Flues

The furnace must also be given a good cleaning, the brick work and grates examined and repairs made if necessary. Do not neglect even small cracks or holes in the fire brick lining of the furnace, for the fire and heat will do destructive work rapidly if it once gets started.

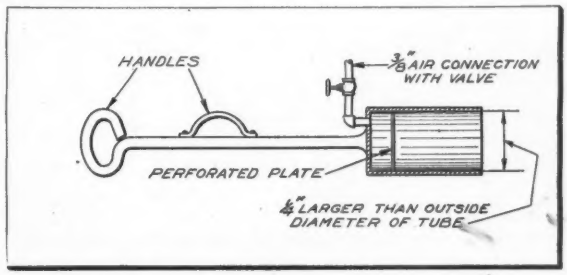


FIG. 2. FORGE FOR HEATING TUBE ENDS

If large quantities of dirt have collected on the tubes, it should be scraped off with scrapers made for that purpose.

After the combustion chamber and furnace have been cleaned and the outside of the tubes scraped, an air hose with a nozzle made of ⅜-in. pipe about 4 ft. long should be taken into each of the passes and the combustion chamber and furnace and all loose dirt blown from between the tubes. It will be found much more pleasant and satisfactory to inspect all parts closely if the cleaning has been well done.

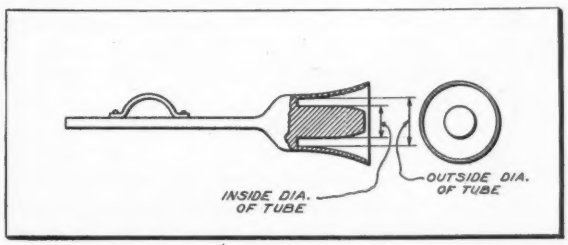


FIG. 3. SWAGE FOR TUBE ENDS

The baffles should be examined the day before the boiler is let down. This can be done by looking through the holes used for flue blowing and the doors used for entering the different passes. Where the baffles are leaking, flame, sparks or light will be visible and those places should be noted and examined more closely when the boiler is down. Another good way is for one man to get on one side of the baffle with a light that can be extended between the tubes and another man on the other side can see the light through any holes that there may be.

Holes can be patched well with asbestos cement put on by using a piece of wood about ½ in. thick, 1½ in. wide and long enough to reach the spot to be patched. By a little patience and practice this will not be a difficult job.

A filling of asbestos cement should be packed between the headers at both ends to keep the cool air from going in. Also, the space between the bottom of the mud drum and the top of the rear wall should be packed with a layer of thick hair felt. This material is excellent for this purpose, as it makes an air-tight job and allows for expansion. Under no condition should the mud drum rest solid on this wall.

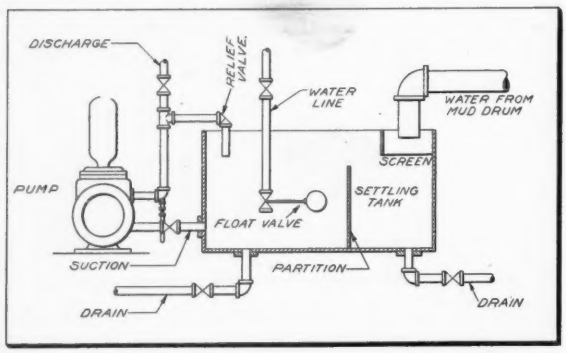


FIG. 4. SETTLING TANK AND CONNECTION MAKING POSSIBLE THE REUSE OF BOILER WASHING WATER

Inspection

This type of boiler is suspended from beams by means of bands around each end of the drums. By this it will be seen that a careful inspection of the nipples between the drums and headers is necessary whenever possible. The strain on these nipples is great and if one should give way, the result can easily be imagined. A good torch and a light inspector's hammer will show the condition of the nipples. If any are found thin, they should be renewed at once. Do not wait for them to begin leaking or for the boiler inspector to tell you about them.

Most of the tube defects will be found to occur in the 2 bottom rows and close to the bridge wall over the grates. Small bags may be found that are of no consequence, but any that show the metal to be thin should be considered sufficient cause to put in a new tube.

Removing and Replacing Tubes

Tubes are taken out by ripping the ends and then bending them in, so that the tube can be turned in the holes. Then use a 3-wheel pipe cutter and cut the tube in two close to the bridge wall. The cutter can be held on the tube and a pair of chain tongs used for turning. If the new tube is loose in the holes, shims of galvanized iron should be used.

If a tube that cannot be reached with a pipe cutter, has to be removed it will have to be taken out full length through the hand-hole. In some cases this is impossible, owing to blisters or bags and then several good tubes will have to be cut out to get at one defective one. This seldom happens, as tubes above the second row from the bottom rarely have bags and are generally straight.

When a cast-iron header is discovered to be defective it must be replaced with a new one and this is not nearly so hard a task as it at first appears. The old header is easily broken into pieces with a sledge hammer and heavy chisel bar.

The most difficult part comes next and that is getting the tube ends back to their original size, which has been changed by former expanding. First, the tube end must be heated to a blood red heat by means of a forge made to fit over the outside of the tube. It should be about ¼ in. bigger than the tube.

The tube is plugged about 6 in. from the end with fine blacksmith coal, and then coke is put in. Then the forge is filled with coke and after lighting is held over the end of the tube and the air turned on enough to make a hot fire. It takes a very short time to heat the tube, so care must be taken not to burn the whole end off. When the required heat is obtained, the fire and coal are jerked out of the tube with a piece of bent iron and the swage is put on and hit 3 or 4 strokes with a light sledge hammer.

The swage is made of iron and the head end made slightly bell shaped so that it will fit over the tube end. The inner part of the swage has an outside diameter exactly the same as the inside of the tube. The space between the inner and outer parts is about 3 in. deep and the bottom of this space is the part that puts the tube end to the required inside and outside diameter.

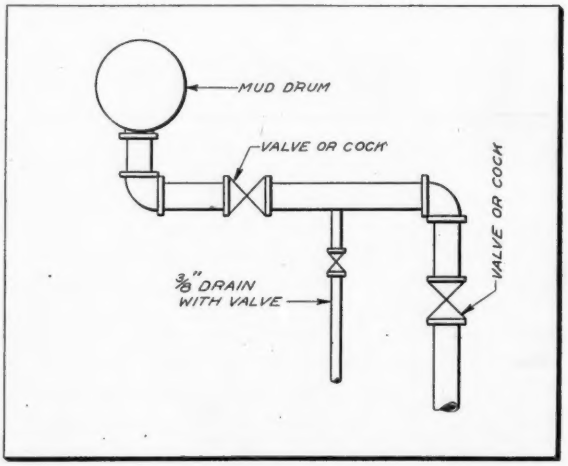


FIG. 5. BLOWOFF PIPE PROVIDED WITH A DRAIN

After all the tube ends have been swaged they are blocked in place by means of pieces of wood and then the new header is set in place and the tubes are rolled.

Wrought steel headers that are now being made and used entirely by the Babcock & Wilcox Co. will never have to be taken out on account of cracks; but if one should have to be replaced for any cause, the only way to get it out would be to cut out the tubes that are connected to it and put in new tubes as well as header.

Rapid Cleaning

I visited a plant where cleaning a boiler was a very particular thing, as the boiler power was barely sufficient when one was down. Often the cleaning would just be begun, when the boiler would have to be filled and fired. To guard against delay only 12 hand-hole plates were taken off at a time, the turbine cleaner was run through the tubes and the plates were put back on again. This was kept up till all the tubes were cleaned and all the rest of the work was done in the same careful way.

In that plant it never took over half an hour to have a dead boiler ready for filling.

In large plants when boiler washing is done every day, or in places where water is scarce or expensive, the same water can be used over and over for boiler washing. This is done by using a tank and drains to collect the water after it leaves the mud drum. A screen must be used to catch the scale and the tank must be built with 2 compartments, 1 to act as a settling tank for dirt and first scale that gets by the screen, and the other to receive the overflow of clean water from the settling tank. The pump will get its suction from the second compartment and there will also be a float valve and float in it to keep it full, as there will be some loss by leakage. The relief valve on the pump discharge can also discharge into this second compartment. Don't fail to clean this receiving tank whenever necessary.

Attention to Fittings

Now the water column and its connections need particular attention. If there are valves between the boiler and column, the bonnets must be taken off and the disc and disc holder examined, as they might have come loose and by so doing block the lines. Use only gate or angle valves, for a globe valve is likely to become clogged. If angle valves are used, put the pressure side toward the boiler; then, in case the disc comes off, the valve will still be open; this would not be the case if it were put on the other way.

Take the stems out of the glass gage cocks and run a rod through and into the columns, to see that these are not full of scale. See that the gage cocks are in working order and not leaking. Examine the valves on the blowoff lines from the column and water glass; if those valves leak, it will show a false water level. The blowoff should be used 3 or 4 times each watch.

Check valves on the feed line and the valves between the check and the boiler also need attention. Fusible plugs must be cleaned both on water and fire side, for if they are covered with scale or dirt they are useless. In cases where the fusible plug is on top of the drum, the piece of pipe that extends through the plate and below the water line should have a rod run through to make sure that it is clear.

Blowoff valves from the mud drum must be repaired if they have been leaking. Have 2 valves or cocks on the blowoff with a ⅜-in. drain between them. This drain will always let you know when you have a leaky valve.

All bolts used in flanges on blowoff lines, or in any lines connected with a boiler, must be full size that the holes are drilled for and must be long enough to reach through the nut at least one thread.

When everything has been done, the boiler should be filled full of water from the heater and pressure pumped up slowly till the working pressure is reached and then a man must go into the furnace, combustion chamber and the upper passes and see that there are no leaks. If any leaky tube ends or nipples are found, the boiler should be emptied and the tubes rolled. Do not allow any leaks to go unfixed.

Steam gages and safety valves must be tried to see that they correspond. The steam gages should be taken down and tested 2 or 3 times a year. The safety valves must be tried by hand once every 24 hr. to keep them from sticking.

If boilers are thoroughly and properly cleaned and inspected when they should be, a lot of trouble and expense will be saved.

At the meeting of the National Gas Engine Association in Toledo new officers were elected as follows: President, R. A. Oglesby of the Knoblock Heideman Co., So. Bend, Ind.; Vice-president, H. D. Lauson, of John Lauson Co., New Holstein, Wisc.; Treasurer, O. M. Knoblock, So. Bend, Ind.; Secretary, H. R. Brate, Lakemont, N. Y.; Executive Committee, H. D. Lauson, H. G. Drefendorf, E. J. Perkins.

The next meeting place was not decided on, but it is proposed, if possible, to arrange for a meeting on some steamship on the Lakes, thus combining business with a vacation trip. Toledo asked for the next Gas Engine Show in 1914.

In a speech at the banquet, it was shown by Prof. Magruder that upward of 2,500,000 internal combustion engines are in operation in the country, 1,000,000 being automobile engines of an average of 25 hp. and the balance farm engines of 7 hp. average and increasing at the rate of 500,000 engines a year. He gave no figures in regard to the number and power of blast furnace, producer, city and natural gas engines, but some idea can be gained from the fact that within 50 miles of Chicago there are some 40 blast furnace gas engines with horsepower of 3000 each or over, and in Chicago possibly 700 engines using city gas, averaging 17.5 hp., and in Philadelphia 1276 such engines. If all the engines using gasoline were to be operated 1 hr. each day at normal load, it would use up the gasoline production of the country, leaving none for Sunday joy rides.

One suggestion brought out was that various associations interested in gas engine problems unite to support a fellowship for investigating such problems at some university, the results of investigations to be available to members of all supporting associations. The expense of such a fellowship, utilizing the university facilities would be less than the amount spent yearly by many a maker of engines in his own experiments.

Among the important requisites for safe buildings considered by the National Fire Protection Association are fireproof construction, coverings for windows and doors to prevent spread of fire, automatic sprinklers, co-operation of building owners.

Steam Piping for Paper Machines

SIMPLE METHODS OF UTILIZING EXHAUST STEAM TO BEST ADVANTAGE. BY H. H. LATIMER

AS a general rule, the drying cylinders of a paper-machine are heated by exhaust steam from the engine that drives them. There are some few mills where the engines run condensing and the dryers are heated by live steam at a reduced pressure; but this has been found to be a very inefficient method and the mistake is acknowledged.

Let us consider the former case where exhaust steam is used. At times, when a heavy paper is being made, the heat obtained from the exhaust steam is insufficient

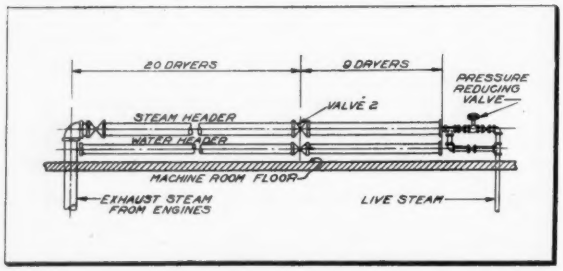


FIG. 1. EXHAUST AND LIVE STEAM PIPING TO PAPER MACHINES

for drying and it becomes necessary to introduce live steam into the exhaust steam header. What is the result? Back pressure on the engine takes a leap and more power is required to run the machine. Almost every steam engineer, who has run in a paper mill, has met with this trouble, and many a good engine has suffered as a consequence.

To overcome this difficulty, a number of papers mills have arranged their steam piping as is illustrated in the accompanying sketches and the installation has proved satisfactory in every case.

The valves on the steam header are so arranged (see Fig. 1) that it may be used as one unit or be subdivided into 2 separate and distinct sections. If, when running on a certain grade of paper, it is found that the heat obtained from the exhaust steam is sufficient for drying the paper, Valve 2 is left open and the header is one continuous length. When running on another grade, however, it is found that some live steam will have to be used. Valve 2 is then closed and the header is divided into 2 sections.

Suppose the paper machine has 29 drying cylinders. Valve 2 has been so located that exhaust steam enters the first 20 dryers and live steam the remaining 9. By this means we have heated the dryers to a sufficient degree and yet have avoided increasing the back pressure on our engine. The drain pipe for carrying away the water of condensation must, of course, have a valve similarly located to valve 2 on the steam header. Paper-makers whom I have questioned are unanimous in stating that they prefer this arrangement, since they can vary the temperature of the last section of dryers at will, which greatly facilitates the drying of the paper.

At times it is found that the exhaust steam is more than sufficient to dry the paper and some must be allowed to escape. In some mills this surplus steam is allowed to go to the atmosphere by way of a relief valve; this, of course, is absolutely wrong. In other mills this steam is utilized in heating coils or a feed-water heater, or perhaps, in both. A method of piping this surplus exhaust, and one which has been found to work very satisfactorily, is illustrated in Fig. 2.

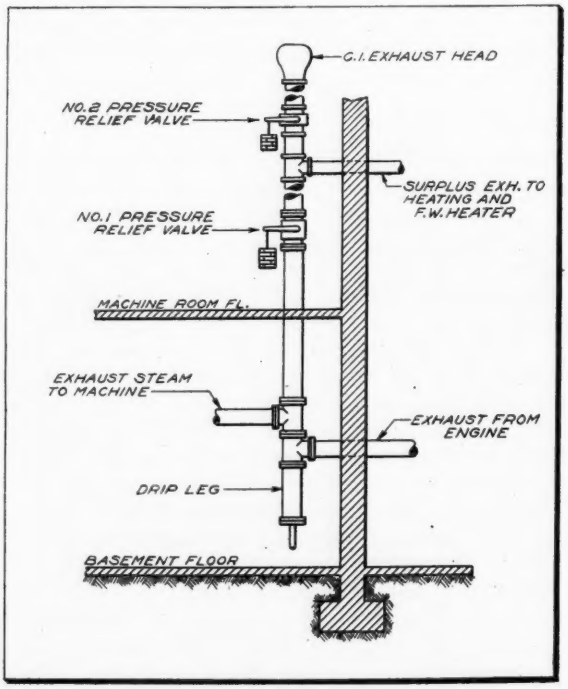


FIG. 2. PIPING ARRANGEMENT TO MAKE USE OF SURPLUS EXHAUST STEAM IN PAPER MILL

Pressure relief valve No. 1 is set so as to carry the desired pressure in the dryers. If the exhaust steam is more than enough to maintain this pressure, the surplus is relieved through valve No. 1 to the heating coils, or feed water heater. If, for any reason, the steam is not needed there, an atmospheric relief valve, No. 2, allows it to escape to the atmosphere.

AT A RECENT MEETING of the Board of Trustees of the University of Illinois, R. Y. Williams was appointed Director of the Miners' and Mechanics' Institutes, which are to be established under the direction of the Department of Mining Engineering. Authority for the establishment of these institutes was granted by an act of the State Legislature in 1911; but no appropriation was made to carry out the authorization until the latter part of the recent session of the Legislature, at which time an appropriation of $15,000 per annum was included in House Bill 895 (a bill for the ordinary and contingent expenses of the State Government). The purpose is to assist men to pass the tests required by the State before they can hold official positions about the mines.

Mr. Williams graduated from Princeton University in 1901 with the degree of Bachelor of Arts, and he received the degree of Engineer of Mines from Columbia University in 1904. For several years he was in charge of mines in West Virginia, and since 1908 has been stationed in Urbana as Mining Engineer for the United States Bureau of Mines.

Electrical Machinery and Appliances

For Generating, Transmitting and Using Current

Measurement of Power in A. C. Circuits

USE OF THE WATTMETER, AMMETER AND VOLTMETER, FOR MEASURING THE POWER IN SINGLE, TWO AND THREE-PHASE CIRCUITS, BALANCED AND UNBALANCED. BY CARL D. KNIGHT

MEASUREMENT of power in alternating-current circuits by means of indicating instruments often presents problems which are more or less confusing. It is possible, however, to give a few simple rules which should enable one to make all ordinary measurements of this kind.

In direct current work, power is always the product of volts and amperes used; if a number of lamps require 10 amp. at 125 volts, the power used by the lamps is $10 \times 125 = 1250$ watts.

With alternating current, however, the product of volts and amperes does not always give the power, although it may in certain cases. It is, therefore, necessary to use a wattmeter to determine the power. The wattmeter is an instrument having one pair of terminals which are connected into the line like an ammeter, and one pair which are connected across the line like a voltmeter. Figure 1 shows a wattmeter connected to give the power used by a number of lamps.

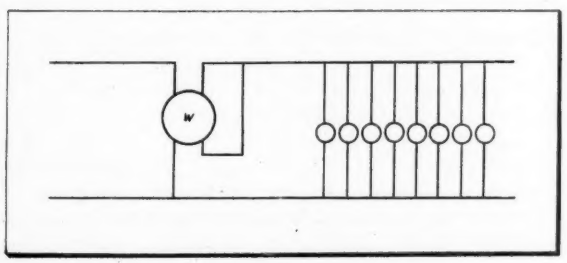


FIG. 1. WATTMETER CONNECTIONS

If an ammeter and a voltmeter are included in the line as shown in Fig. 2, it is possible to obtain the quantity known as the power factor. The power factor may be defined as the ratio of the true power to the apparent power. It is found by dividing the watts, as shown by the wattmeter, by the product of volts times amperes. Suppose the instruments in Fig. 2 to read as follows: Watts 1000, volts 125, amp. 10. The power factor is then $\frac{1000}{125 \times 10} = 0.8$, or as it is more often expressed, 80 per cent. This is the only general way of measuring power in a single-phase circuit.

Two-phase power can be measured in exactly the same way as if it were 2 distinct circuits. That is, a wattmeter should be placed in each phase and the total power is the sum of the 2 wattmeter readings. If it is certain that the power in each phase is the same, then a wattmeter placed in one phase will give the total power by multiplying its reading by 2.

The power factor of the 2-phase system is the power factor of either phase, if the system is balanced—that is,

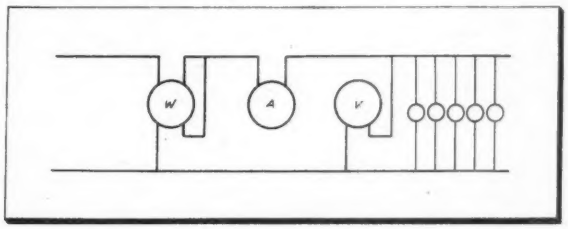


FIG. 2. METHOD OF CONNECTING WATTMETER, AMMETER AND VOLTMETER IN CIRCUIT

the same power in each phase. If the system is not balanced, the power factor is a meaningless term. A load of polyphase motors will give practically a balanced load, while a mixed load of lamps and motors will usually give an unbalanced load.

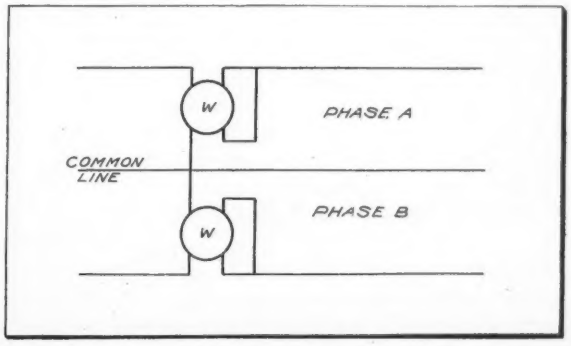


FIG. 3. CONNECTIONS FOR MEASURING POWER IN THE 2-PHASE SIDE OF A 2-PHASE, 3-PHASE CIRCUIT

In measuring power in a 2-phase, 3-wire system the current coils of the wattmeters should not be connected into the common wire, but should be connected as in Fig. 3.

To measure 3-phase power, either balanced or unbalanced load, make connections as in Fig. 4. The power

is now given by the sum of the 2 wattmeter readings if the power factor is above 0.5, or by the difference if below 0.5. To determine whether to add or subtract the 2 readings, place lead *a* of wattmeter W_2 at *b*. If the meter tends to deflect backwards, subtract the readings; if it does not tend to deflect backwards, add the readings; if the power factor is exactly 0.5, one meter will read zero.

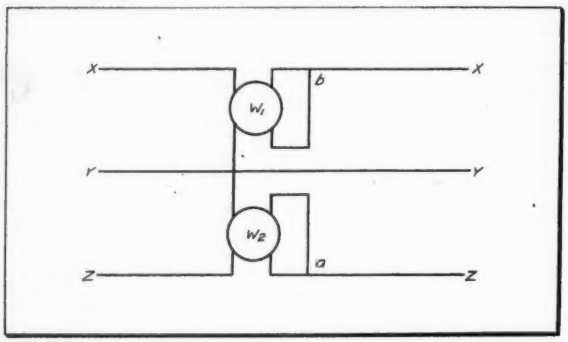


FIG. 4. WATTMETER CONNECTIONS FOR A 3-PHASE CIRCUIT

The following example will, perhaps, make this clearer. Suppose W_1 to read 1000 watts and W_2 400 watts. On changing the lead of W_2 from *a* to *b*, the pointer of W_2 tends to deflect backwards. The total power is, then, 1000 — 400, or 600 watts. If on changing the lead of W_2 from *a* to *b*, the pointer of W_2 had deflected in the right direction, the power would have been 1000 + 400, or 1400 watts.

If the load is balanced—that is, if the currents in X, Y and Z are all equal—the power factor of the circuit can be determined from the following expression:

$$\text{Power factor} = \frac{\text{Watts}}{1.732 \times E \times I},$$

where E is the voltage between any 2 wires, and I is the current in any one wire. In the example just given,

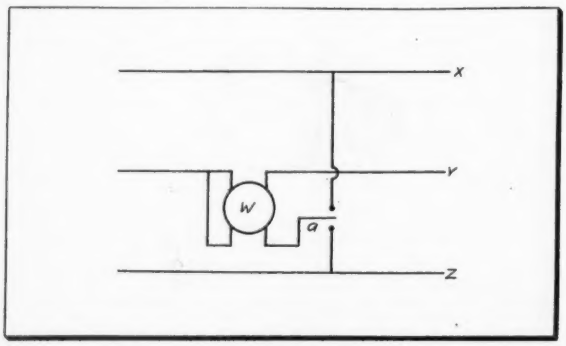


FIG. 5. WATTMETER CONNECTIONS FOR BALANCED 3-PHASE CIRCUIT

if watts = 600, E = 100, and I = 8.3, the power factor is 0.24. If watts = 1400, E = 100, and I = 10.1, the power factor is 0.80. If the load is unbalanced, the power factor is meaningless.

In cases where the load is balanced, satisfactory results can be obtained by the method shown in Fig. 5. The current coil of the wattmeter is connected in one wire, as Y, and one terminal of the voltage connected to Y also. The other terminal of the voltage coil is so arranged that it can be connected to either X or Z. Read the meter with *a* connected to X, and then with *a* connected to Z. If the meter does not have to be reversed between readings, add the 2. If it is necessary to reverse, subtract one from the other.

In case the power factor of a balanced 3-phase load is desired and no ammeters or voltmeters are available, it may be determined from the 2 wattmeter readings by use of the curve shown in Fig. 6. If the larger wattmeter reading be always called W_1, and the smaller W_2, divide W_2 by W_1, and find the point on the horizontal scale corresponding to this result. From this point go

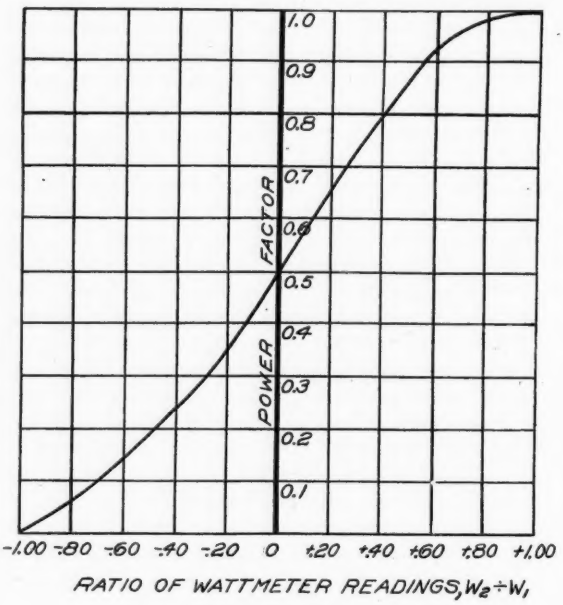


FIG. 6. CURVE FOR DETERMINING POWER FACTOR OF A BALANCED 3-PHASE CIRCUIT

vertically upward to the curve and then horizontally to the vertical scale. The reading on this scale will be the power factor. If W_2 be negative, use the curve at the left of the vertical scale; if W_2 be positive, use the portion of the curve at the right of the vertical scale.

Using the same wattmeter readings as in the previous example, $\frac{W_2}{W_1} = \frac{400}{1000} = 0.4$, and the power factor is 0.80 or 0.24, according to whether W_2 is positive or negative.

A careful observance of these rules should enable one to measure the power in any circuit with the usual indicating instruments. There are upon the market several special devices for the measurement of polyphase power, any of which must be used according to the rules accompanying it.

HILZ BROS. CO., Hamilton, Ohio, is installing a new power plant, which, when completed, will enable the company to take care of its own electric power.

Grounded Motors

Methods of Grounding and Tests Applied. By T. H. Reardon

WITH the increasing use of electric motor individual drive, the number of such motors in use in large establishments is so vast that anything short of personal observation would fail to convey to the mind the extent to which the electric motor is supplanting other methods of machine drive.

With this vast increase in one of the more important applications of electricity, immunity from danger in connection with its use is a matter that assumes more than ordinary importance.

In practically all electrical systems there is a certain amount of leakage from line to the earth due to the fact that the line insulation, while sufficiently high for practical purposes, is not so perfect that leakage from line to earth is absolutely prevented; this means that if an individual should accidentally make a path from a wire to the earth, he would in all probability, receive a shock which, if not fatal, would at least be painful and severe.

In all electric motors, whether direct-current or alternating-current, if the insulation on the wire within the apparatus breaks down, the bare copper may be immediately in contact with the iron composing the framework of the motors.

Under such conditions, if the iron framework or fuse boxes, oil switches, motors, etc., are not well connected to earth, a person making contact with such a piece of apparatus is likely to become a conducting bridge from such piece of apparatus to some earth connection, thereby receiving a shock of more or less severity, depending upon the quality of the line insulation at some opposite point where the difference of potential is much higher or lower than at the point at which the individual made contact.

It should be borne in mind that with any given line voltage the alternating current is much more dangerous, as the *effective voltage* is always stated in speaking of alternating current.

An alternating electromotive force is constantly varying between zero and a maximum, the maximum being the effective multiplied by some particular factor depending on the form of the current wave.

For the most common form of current wave, i.e., the sine curve wave, the maximum electromotive force equals the effective electromotive force multiplied by the square root of 2, or 1.414. Example: $550 \times 1.414 = 777.8$ and $777.8 \times 1.414 = 1099$, respectively, showing the effective and maximum values of common voltages employed in 2-phase alternating-current power circuits.

The individual who makes a cross connection between a middle and an outside wire of a 550 2-phase a.c. circuit will receive 777.8 volts at the peak of the a.c. wave and if it is across the 2 outside wires (777.8), he will receive 1099 volts at the peak of the wave. Between any of the above wires and a ground connection, or between the iron framework of apparatus that is charged and the earth he will receive something less—never more—than the potential that exists directly across between the wires in question.

As pointed out above, the severity of the shock received by a person making a ground connection can never be predicted; it depends on the excellence of the contact made and also on the resistance of the earth path from wire to wire.

As a safety precaution, it is therefore necessary to ground the framework of electrical apparatus; and the means of doing this and the tests to be applied to determine whether a good ground connection exists or not, will receive attention in what follows.

First, the wire used for a ground connection should have ampere carrying capacity considerably in excess of the ampere capacity of the apparatus that it is intended to protect; otherwise, in case of trouble, the ground wire may burn off first, thus leaving the apparatus charged, unprotected and in a dangerous condition. When grounding is accomplished by clipping conduit pipe directly to framework of apparatus, the conducting power of the iron clips, screws, etc., should be taken into account, as the strength of the chain resides in its weakest link.

Great pains should be taken to remove paint from the outside of pipes that are to receive electrical ground clamps (twisting a wire around a pipe, even if soldered, is poor practice), as paint and varnish are insulators to a certain extent, sufficiently so in trials made by the writer to prevent current flow with an a.c. voltage of 777.8 volts (effective).

For ground connections, water or steam pipes are to be preferred to anything else, as they are buried in the earth or connected to steam boilers, etc., which always have an earth connection. As such pipes, however, in places where changes are continually occurring, are liable to be cut off, it is desirable when making ground tests to test each piece of apparatus between itself and an absolute ground.

A dozen machines may be interconnected electrically with each other by means of a pipe or any other medium and still not be connected to earth.

If all ring between a certain common point individually it is only necessary to ascertain that the common point is in communication with the earth.

It would undoubtedly be good practice in all places where electric motors are used, to run a special ground wire through each room or department, this ground to be absolutely connected to earth at one point; this would remove a whole lot of uncertainty as to the reliability of pipe connections, insulating effect of paint, corrosion, etc.

The usual method of making ground connection tests is by means of a bell and 1 or 2 cells of dry battery, one terminal being connected to the apparatus in question and the other terminal being connected to earth. Then if a ring occurs, it is understood to mean that after forming one ground a previous ground must exist, as 2 grounds are necessary for the completion of a circuit.

The bell and battery will not indicate a ground if there is much resistance in the earth circuit, or in the connections forming a part of the earth circuit; this, however, is an advantage and it tends to make the test more reliable, and shows that the ground indicated is a good one.

Sometimes in temporary construction work out of doors, it is necessary to wire up portable apparatus and provide it with a ground connection, and this in cases where it is very difficult to make a proper ground connection.

The writer has seen a piece of 1-in. pipe driven 3 or 4 ft. into the ground and a wire wrapped a few times around it for a ground connection.

This is a very poor substitute for a ground connection. Its value may be tested out in certain cases as follows:

Place a bank of 5 110-volt carbon incandescent lamps between different live contacts in the fuse box and this ground; if lamps come up to a dull red, ground fairly good, if not make another similar ground on opposite side of circuit and test both sides of circuit (outside wires) with 2 lamp banks simultaneously; if this gives no red on lamps, ground is no good; this refers to a 550-volt 2-phase 3-wire circuit in particular.

Electrical Correspondence

Equalizer Connections

I SHOULD like to get a little information in regard to the sketch shown in Fig. 1. The firm has 3 generators that they wish to run in parallel compounded. They had a man wire them up to run in parallel. The size of wire and connections he made are shown on the sketch.

These machines have some peculiarities about them. The 80-kw. machines will run very well with the other machines with the series winding short-circuited, and

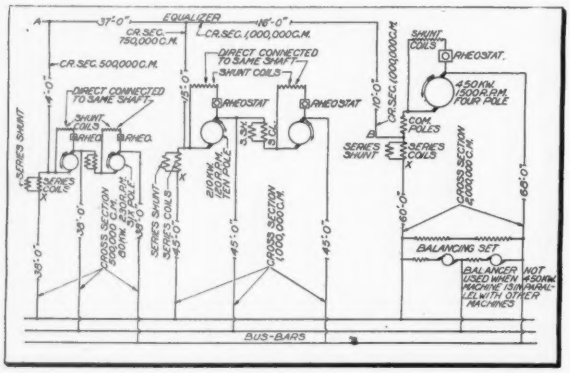


FIG. 1. DIAGRAM OF CONNECTIONS TO GENERATORS RUN IN PARALLEL

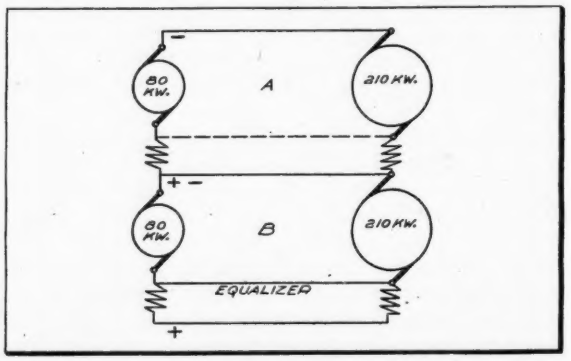


FIG. 2. IMPROPER AND PROPER CONNECTIONS FOR PARALLEL OPERATION

the 210-kw. machines will run satisfactorily, in parallel with the 450-kw. compound unit, with no equalizing connection. When the equalizer is cut in, one machine will take the load, then the other, continuing in this way until the breakers are knocked out. This man who made the equalizing connections and also compounded the 210-kw. machine said, that the 80-kw. machines were overcompounded. So he took off about 4 turns of German silver of the series shunts, leaving them so they cut out the series winding entirely when the shunts are in parallel with the series coils.

I think the series shunts will have to be built up again on the 80-kw. machines, so as to give them the same degree of compounding as the other machines—that is, in proportion to the load they have to carry. I suppose the degree of compounding will have to be found by running each machine separate from the others, noting the voltage at different loads. When 2 machines are in parallel the series shunts are also in parallel, making one large series shunt, any change in one affecting the other in the same proportion. Therefore, I think that there could be some resistance inserted in conductors at points marked X on the sketch. F. A. M.

A. The following analysis of your diagram will, no doubt, show you wherein the remedy lies:

In the first place, the equalizing connections are not properly made. To make this quite clear, refer to Fig. 2.

You will note that you have in reality 2 sets of machines, each set consisting of an 80-kw. and a 210-kw. machine in parallel, these sets in turn being in series. Thus, at B you have the 80 kw. in parallel with the 210 kw., and the equalizer between the series fields in place. In set A, however, you have no equalizer, and as a result the 2 machines in this set will not operate, as one will take all the load and reverse the polarity of the other machine, instantly causing a heavy surge of current through the 2 generators and tripping the breakers.

In order to make this combination work, an additional equalizer cable, as represented by the dotted lines, would have to be used. Shunting either series field in set A (or B) would not affect the division of load between the 80-kw. and the 210-kw. machines, but a shunt on set A, for example, would tend to change the division of voltage between the 2 sets. That is, if set A were shunted across either field or across both fields, while B set were left unshunted, B would generate a higher voltage than A, and there would be unbalanced voltage on the 2 sides of the system, or as it is sometimes expressed, the neutral would shift.

In operating sets as above (3-wire compound generators) in parallel, 2 equalizers are used in practice. When such sets are to be operated with a 2-wire dynamo, additional changes must be made. A scheme as in Fig. 3 might be used, but it requires some care in paralleling, as it will be noted that the armatures are parallel first by closing the equalizer switch. This means that a shunt and compound machine are being operated in parallel until main switch is closed, cutting in the second series

field. A double pole switch might be used to close equalizer and main switch simultaneously, but there is a complication of copper work and cables if this is done. If a double pole switch is not used, and equalizer is closed with the shunt machine a little higher than the running compound generator, the series field will be receiving current in a reversed direction, and the breakers immediately open. A study of Fig. 3 will make this plain.

There is, however, a simpler way of connecting machines, and I believe this would be the better scheme in your case, as it would save running additional equalizing cables. Figure 4 shows this.

The one drawback with this method of connection is that the compounding does not depend on the changes of load on the negative side of the system. This is not a serious defect, however, as the load is, or ought to be, nearly balanced.

You are quite correct about the effect of series shunts on division of load. A shunt placed across any one field in Fig. 4 would cause the voltage of that machine to be lowered, say (a) volts. If the shunt were placed across 2 corresponding fields in the sets in parallel, a shifting of the neutral would result. This shifting would be increased from the fact that the shunt would reduce the resistance of that part of the circuit and cause an increased proportion of current to flow through series connected with it. That is, a shunt across A, Fig. 4, would not only reduce the voltage of its machine, but it would cause more current to flow through B, and so raise the voltage of the other machine in the same set ("set" meaning in this case on same shaft).

The fields would have to be shunted so as to keep the voltage across each side of circuit balanced as described above, and resistance introduced as shown in your sketch to divide load between the sets.

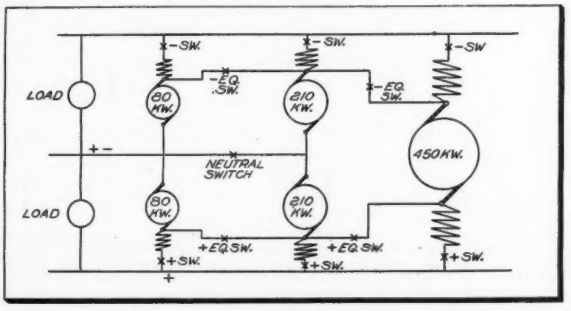


FIG. 3. USE OF 2 EQUALIZER BUSES IN 3-WIRE SYSTEM

Without being "on the job," it is difficult to explain the action of the 450-kw. and the 210-kw. machines, with and without an equalizer. The following theory may fit your case:

The fields are, as you say, shunted to quite a degree. Now, if the (+) machine had its series reversed it is possible that the negative compounding of the (+) machine might exactly overcome the positive compounding of the (—) machine. When the equalizer is open, all current passes through each series (and shunt) and there would be a slight unbalancing of the 2 sides of system, but the total generated voltage would remain a constant. That is, the (—) machine might generate 130 and the (+) machine, 110, making a total of 240 as before. Thus, we would have practically a shunt machine in parallel with a compound wound machine, and the machines operate well. Now, when the equalizer is closed, no longer does the current in the 2 series coils remain equal. The current divides between the 450-kw. series and the (+) 210-kw. series, while the negative series continues to carry full load current.

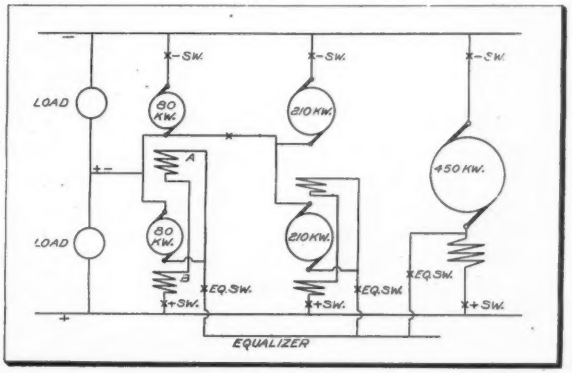


FIG. 4. CONNECTIONS FOR THROWING MACHINES IN PARALLEL EASILY

There is nothing to equalize this series, and the result is practically 2 compound wound generators in parallel, with no equalizing connections, so, of course, the breaker opens as soon as the surge of current has reached sufficient magnitude.

What Causes the Static Charge?

THE COMPANY by which I am employed as chief engineer owns, not only the plant where we have our headquarters, but various other industries located in several different parts of the country, and to which places I have to go at intervals, on inspection and repair work, owing to the fact that all their prime movers are directly under my care. During my last 2 or 3 trips to one of these points I have noticed a peculiar action as regards motors along a certain newly constructed line. The plant of which I speak is a power and lighting plant, and lines have heretofore led to the east, south and west from the plant, carrying 2300 volts, and also a couple of sets of secondaries.

During the past year, however, we have extended our services considerably, by leading away to the north for a number of miles, and tapping a new territory. Our first point of any importance on the new line is several miles from the station and we have "stepped up" our primary from 2300 volts to 6600 volts, stepping back to 220 volts at the point of distribution. The peculiar thing regarding this line, and which has caused me to wonder a great deal, and to worry more, is this—that any motor placed under the new line, or practically so, but reached by another set of 2300-volt lines (of which there are 2 sets besides the 6600 set, all running parallel; one set runs but a few hundred feet and is stepped down to a set of motors; the second set runs 2½ miles and is then stepped down to another set of motors;

while the 6600 goes on for several miles farther), fills its frame with a static charge, which at times, will knock a person down, while again the charge is very weak.

At first I thought the motors were grounded and spent a number of days in cutting out the coils and testing. Still the same thing would happen. A day or 2 later I went to the set of motors 2½ miles out, and found them in the same condition. This static charge does not seem to be of any harm to the motors. On going to this second set of motors and finding it, as I supposed, with a bad set of grounded coils, I sent out more motors, one of them still in its crate from the factory, and connected them to the lines, bringing to the shop at headquarters the 2 which I had removed.

On setting them up in the testing room, however, I found no indication of anything wrong, my ground having disappeared. Try in any way I would, I could get no sign of there ever having been a ground, not only on one, but on both. I then sent out to the first set and brought them in, leaving in their place 2 motors direct from the factory. On testing these 2, I had the same results—nothing wrong—while on going out to examine the 2 sets of new motors, I found the old conditions prevailing.

Since then I've changed several times, hoping to reach some satisfactory conclusion, but as yet am in the dark. Even after these motors have stood idle for weeks they give, on being grounded, quite a static spark. Cut the current off the 6600-volt set of lines and the spark stops, and if motors are in service—as they draw a much heavier charge when in motion—they are resentful of any hands being laid upon them. In a great many years' service I have never bumped into anything like this before, and so I am entirely at a loss for an explanation.

None of the motors other than those in the locations named are affected in the least, yet taking one of the unaffected motors and placing it at these points causes it to take on a charge as do the others. Prior to installing the 6600 volts service, paralleling these 2 sets of lines, we had no such trouble with them.

Perhaps some of the readers of Practical Engineer may have something to offer in explanation, and if so I would be pleased to have them do so, through the medium of these columns. JOHN PIERCE.

Telephone Trouble

IN OCTOBER 15 issue, H. B. P. asks for information about his telephone line. From his letter I take it that his high tension line of 20,000 volts and his telephone line are on the same cross arm. If so, it is not a surprise that he gets a shock when using the phone. Putting a telephone line on the same cross arm with a high tension line is dangerous practice, to say the least. A telephone line, if on the same pole line, should be at least from 3 to 4 ft. below the high tension line, and if H. B. P. will place his telephone line 4 ft. below, he will overcome his trouble. The line will not be noisy, and also the shocks will disappear. The noise and shocks are due to induction on his high tension lines.

A. C. RUHL.

IN REGARD to the telephone trouble of H. B. P., would make the following suggestions:

Make sure that every connection is tight. Use sleeves or solder all joints. Have entrances to buildings well insulated and do not use twisted pair wire. Transpose at least every quarter mile. Seven poles is all right with 100 to 150-ft. spans, but is not if using 250 to 400-ft. spans. Rolling transpositions should always roll the same way, and do not use dead end transpositions or transposition insulators.

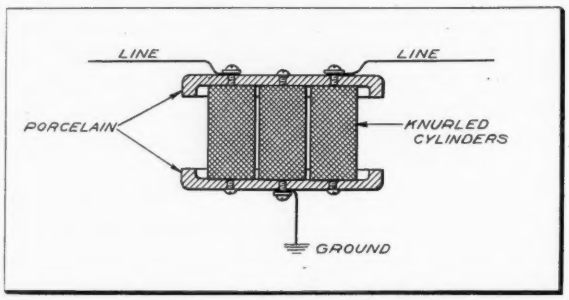


FIG. 1. LIGHTNING ARRESTER CONNECTIONS FOR TELEPHONE LINE

If using the lightning arresters that commonly come with the instruments, discard them and either buy some small 200-volt brass cylinder arresters or make them of the knurled cylinders used on 2300-volt arresters, using 3—2 to line and 1 to ground, as shown in Fig. 1.

If these suggestions do not clear the line, a drain coil should be put on, connected as indicated by diagram, Fig. 2.

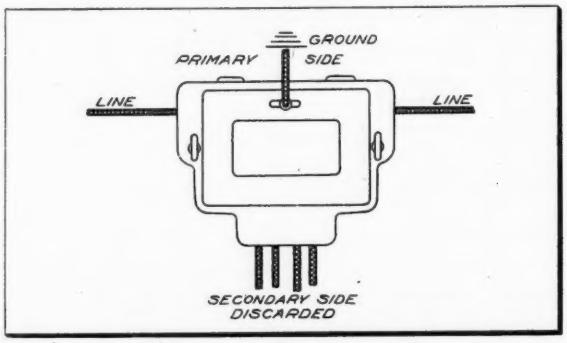


FIG. 2. TRANSFORMER CONNECTED AS DRAIN FOR TELEPHONE SYSTEM

Use any old 2300-volt transformer with a good primary side. One may be needed at each end of line, but I believe one at junction of 6000-volt and 20,000-volt lines would do. An insulated stool should always be used at the telephone. C. E. B.

IN ORDER TO FURNISH power to about 12 coal operations that are located on its holdings, the firm of Montgomery, Clothier & Tyler, of Philadelphia, has installed a plant at Sharples, W. Va., on Coal River, which has cost about $75,000. The plant is one of the most modern in the country, and will furnish power to operations for miles around. The plant is capable of generating 1000 kw.

Foreign Development In The Power Plant Field

ELECTROLYTIC IRON; GAS GENERATOR; BELT TENSION; INSULATING MATERIALS; ACID-PROOF ALLOY. BY J. H. BLAKEY

IT may be remembered that Professor Franz Fischer recently made some remarkable discoveries with regard to the value of electrolytic iron in the construction of electrical machinery. These discoveries seemed at the time to have only a purely academic interest, as there was then no method of producing the metal by this process at a price which would make it available for industrial purposes. Since then Professor Fischer has continued his experiments at the Langbein Pfannhauser plant, with the result that this difficulty seems likely to be overcome. Consequently, the following figures from his experiments may be cited, as showing the improvements which may be expected in electrical apparatus, when the new form of iron can be put to general use. M. Breslauer gives the Electrotechnik Zeitschrift the data below, based on a comparison of 2 3-phase synchronous motors of the same dimensions; the iron in I being electrolytic, and in II the ordinary iron of commerce:

	I	II
Horsepower	3.5	2.5
Weight of iron ..... lb.	44	46.2
Weight of copper ..... "	17.6	15.4
Weight of iron per hp ..... "	12.5	19.5
Weight of copper per hp ..... "	5.06	6.6
Active material per hp ..... "	17.6	26
Efficiency, per cent	83	78.5
Power factor	0.84	0.825
Possible overload, per cent	2.3	2.0
Relation of current idle to full load ...	.435	.48

A comparison of 2 30-kw. transformers gave the following results:

	I	II
Induction ..... lines	13,000	9000
Weight of iron ..... lb.	338	534
Weight of copper ..... "	113	180
Total weight of active material ..... "	418	697
Loss in iron ..... watts	320	287
Loss in copper ..... "	370	332
Total loss ..... "	690	619

From these figures it will be seen that the greater magnetic permeability of the electrolytic iron results in a better output, per lb. of metal, hence the power of a motor can be increased by about 50 per cent, and the weight of transformers can be decreased 30 to 40 per cent.

A NEW PETROLEUM GAS GENERATOR

ZEITSCHRIFT FUR Beleuchtungswesen describes a new petroleum gas generator, based upon the principle of the gasification of the oil by passing it over red-hot bricks. The disadvantage of most gas generators of this kind is that the gasification is incomplete. The apparatus described remedies this defect by means of a filter of coke placed at the outlet of the generator. Into this filter, air under strong pressure is blown and the coke is thus kept at incandescent heat. The result is that the air causes the complete combustion of the smoke and tars which have escaped combustion in the previous heating, thus assuring the complete gasification of all the products contained in the oil.

RELATION BETWEEN THE INITIAL TENSION OF BELTS AND THE PRESSURE ON THE BEARINGS

IN PRACTICE, to determine the initial tension of belts and the pressure produced upon the bearings, formulas are often used which do not take into account all the elements in the case. In reality the weight of the belt is never negligible, and it may modify considerably the pressure on the bearings. It is also necessary to take into consideration the effect of centrifugal force and the elasticity of the belt. In Zeits. des Ver. Deutsch Ingen., M. Duffing discusses this subject, making allowance for all the above-mentioned factors. He shows also that the successive modifications of the tension caused by the alternating contact and noncontact with the pulley, are accompanied by a sort of elastic hysteresis, the effect of which is that the retraction of the belt lags behind the diminution of the tension which produces its elongation. The author comes to the conclusion that the formulas usually employed to determine the initial tension of belts, which do not take into account the geometrical dimensions of the transmissions of which they are a part, are absolutely insufficient, and that the consideration of these dimensions is indispensable for the correct calculation of the pressure on the bearings, whether the pulleys are in continual motion or otherwise.

ARTIFICIAL INSULATORS FOR USE IN THE CONSTRUCTION OF ELECTRICAL APPARATUS

IN L'ELECTRICIAN, M. Passavant describes the qualities which insulators must possess in order to be satisfactory in the construction of electrical apparatus. These qualities are: Resistance to heat, mechanical resistance, incombustibility and resistance to chemical agents and to moisture. He describes the properties of a new artificial insulator, called "tenacite," which possesses all these properties and which can be submitted locally to temperatures as high as 2000 deg. C. without undergoing alteration sufficient to cause any danger from short-circuiting, for instance. Moreover, this material causes the deviation of an electric arc, without sensible deterioration and without disengaging particles which would contribute to the maintenance of the arc. Tenacite is also an excellent calorifuge, or nonconductor of heat.

The author cites, in addition, a number of other artificial insulators which are used by the Allgemeine Elektricitats Gesellschaft, of Berlin. These are: Vulcanite, which is used for articles which must be turned or otherwise shaped; "stabilite," a combination of vulcanite and

iron, used for aerial installations and for cars; vulcanized asbestos, for the insulation of coils, and finally, vulcanized fiber, employed in the form of disks and plates.

The author expresses the hope that certain combustible and even explosive insulators now in common use will soon disappear, seeing that the invention of these new insulating materials leaves no excuse for the employment of insulators which may cause fire or other accidents.

An Acid-Proof Alloy of Iron

The Ironmonger announces that the firm of Borchers and Monnatz, of Aix-la-Chapelle, has succeeded in producing an alloy containing 35 per cent of iron, 60 per cent of chromium and 2 to 3 per cent of molybdenum, which has been found to be proof against the attack of all acids, and even against the combination of hydrochloric and nitric acids, which is known as "aqua regia," and is the only combination of acids known that will dissolve gold or platinum.

Practical Mathematics

Problems in Simple Proportion by Arithmetic and the Slide Rule. By Norman G. Meade

An expression of equality between 2 simple ratios is termed simple proportion and it is used to solve problems in which 3 terms are given and the fourth term is required. In any problem involving simple proportion, of the 3 given numbers, 2 must always be the same kind; the third must be of the same kind as the required terms.

To illustrate this statement let us assume a practical example. If 5 tons of coal cost $15.00, what will 12 tons cost? Since 5 tons and 12 tons have the same unit value, they can be compared and will form one ratio or couplet of the proportion. For the same reason $15.00 and the unknown quantity, which we will denote by $X, will form the other ratio.

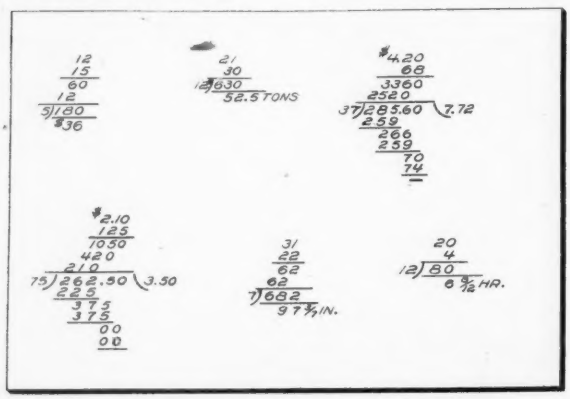


FIG. 1. ARITHMETICAL SOLUTION OF PROBLEMS IN PROPORTION

Equality between the ratios may be indicated by the double colon (: :) or by the sign of equality (=). Thus, to write in the form of a proportion the 2 ratios 5:12 and 15:$X, we may employ any of the following forms:

(a) 5 : 12 : : $15 : $X.

(b) 5 : 12 = $15 : $X.

(c) $\frac{5}{12} = \frac{\$15}{\$X}$

Form *a* is the most extensively used, but the other forms are common. The numbers forming the proportion are called terms and are numbered consecutively from left to right, hence in any proportion the ratio of the first term to the second equals the ratio of the third term to the fourth.

The first and the fourth terms of a proportion are called the extremes and the second and third terms the means. Thus in the given example 5 and $X are the extremes and 12 and $15 the means.

There are 2 general rules for simple proportion: 1. The product of the extremes divided by one mean gives the other mean; and 2. The product of the means divided by either extreme gives the other extreme. In the present example the 2 means and one extreme are given. We therefore divide the product of 12 and 15 by 5 as shown in Fig. 1. The cost of the 12 tons of coal is $36.

Problems in proportion are easily and quickly solved on the slide rule; for simple proportion but one setting is necessary. To solve the given problem on the rule place 5 on left-hand B scale under 12 on left-hand A scale and over 15 on right-hand B scale read 36 on A scale. The setting for this example is shown in Fig. 2.

C and D scales may be used if the third term of the proportion on the C scale does not lie beyond the end of the rule when the slide is set for the first and second terms. The general rule for performing problems in direct proportion on the slide rule may be stated as follows: Place the first term of the proportion on the slide scale opposite the second term on the rule scale and over the third term on the opposite slide read the fourth or unknown term on the rule scale.

To illustrate the working of an example of proportion on the 2 lower scales, let us work out a practical problem. If 12 men can wheel 30 tons of coal into the boiler room in a day, how many tons can 21 men wheel? We have the proportion 12 : 21 = 30 : X. The solution is seen in Fig. 1. To solve this problem on the slide rule move the slide to the right until 12 on C coincides with 21 on D, then opposite 30 on C read 52.5 on D, which is the value of X. The rule setting is shown in Fig. 3.

With the exception of addition and subtraction, if the same operations be performed upon all of the terms of a proportion the proportion is not thereby destroyed.

To illustrate this statement let us assume a problem. In a large manufacturing plant there are 2 power houses. The smaller power house uses 37 gallons of lubricating oil a month at a cost of $4.20; if the larger power house uses 68 gallons a month at the same rate per gallon what is the monthly cost for oil and what is the yearly quantity used and the cost for oil in each

power house? The first part of the problem can be expressed as the proportion, $37 : 68 = \$4.20 : X$. And we find that $X = \$7.72$, Fig. 1.

Expressing this proportion in the third or fractional form we have

$$\frac{37}{68} = \frac{4.20}{7.72}$$

each ratio works out to equal 0.544. Now multiply all of the terms by 12, then,

$$\frac{37 \times 12}{68 \times 12} = \frac{\$4.20 \times 12}{\$7.72 \times 12} \quad \text{or} \quad \frac{444}{816} = \frac{\$50.40}{\$92.64}$$

each ratio still works out $= 0.544$.

What we have proved is that if all terms of a proportion are multiplied by the same number the first fraction will still equal the second fraction. Likewise, had we divided all of the terms by the same number, raised them to a given power or extracted the same root, the first and second fractions would have been equal.

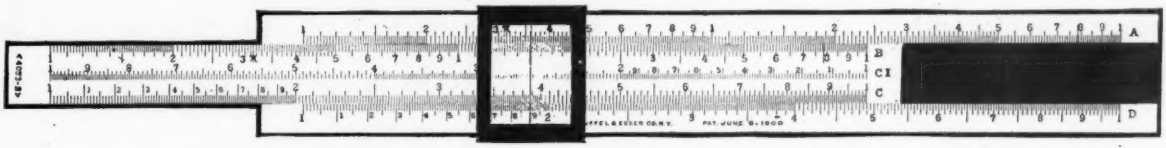


FIG. 2. USE OF UPPER SCALES OF SLIDE RULE FOR SOLVING A PROPORTION

If 75 lb. of bearing metal cost $2.10, what would 125 lb. cost at the same rate?

$75 : 125 = \$2.10 : X$.

To solve the problem on the slide rule place 75 on the slide opposite 125 on the rule scale, then opposite 210 on the slide read $3.50. The decimal point is easily located by the common sense of this problem.

The circumferences of any 2 circles are to each other as their diameters. If the circumference of a circle 7 in. in diameter is 22 in., what will be the circumference of a circle 31 in. in diameter?

$7 : 31 = 22 : X$. $X = 97\ 3/7$ in.

To perform the operation on the slide rule, set 7 on slide opposite 31 on rule; opposite 22 on slide read 97.4 in. on rule.

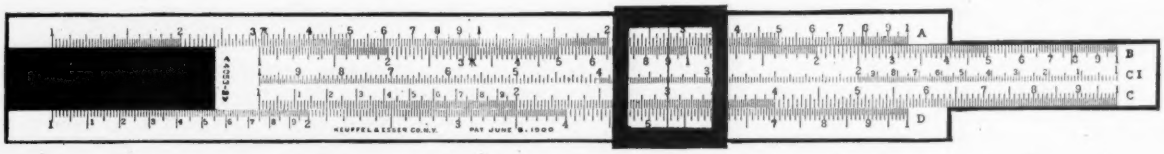


FIG. 3. SOLVING A PROBLEM, USING THE LOWER SCALES OF THE RULE

So far we have dealt only with direct proportion, but frequently we meet with problems involving inverse proportion in which one of the couplets must be expressed as an inverse ratio. In some instances the word inverse occurs when stating the problem; in such cases the proportion can be written directly by inverting one of the couplets.

If a pump which discharges 4 gal. of water a minute can fill a tank in 20 hr. how long will it take a pump discharging 12 gal. a minute to fill it? Evidently the second pump will fill the tank in less time, hence the ratio of pump capacities must be inverted.

$12 : 4 = 20 : X$. $X = 6\frac{2}{3}$ hr.

To solve the problem on the slide rule place 12 on slide opposite 4 on rule; opposite 20 on slide read 6.66.

If 50 cu. ft. of air weigh 4.2 lb. when the absolute temperature is 562 deg., what will be the absolute temperature when the same volume weighs 5.8 lb., the pressure being the same in both cases. We know that weight of a given volume of gas is inversely proportional to temperature, hence, $5.8 : 4.2 = 562 : X$.

Place 5.8 on the slide opposite 4.2 on the rule, and opposite 562 on the slide read 407 deg.

On Elwha Creek, 5 mi. west of Port Angeles, Wash., there has been completed the plant of the Olympic Power Co., which has cost $1,500,000, and includes a lake 5 mi. in length, created by the building of a 90-ft. concrete dam. The plant is, at present, developing about 10,000 hp., and is capable of developing 25,000. Additional turbines and penstocks may be installed to give a capacity of 100,000 hp. as needed. Current is now being transmitted to the towns of Port Angeles, Port Townsend, Forts Flagler and Worden, and other places. The transmission line is 110 mi. long; engineering for the improvement has been in charge of V. H. Reineking, of the firm of Mead & Seastone, Madison, Wis. The contractors of the dam have been the J. O'Heyworth Co., of Chicago, with Patrick Ford as superintendent. The dam was a remarkable piece of work in its final form. In 1910, construction was started, and the dam was completed 2 yr. later by other contractors; but, not being carried down to bed rock, the foot of the dam washed out and an opening quickly formed beneath the dam, emptying the newly formed lake. Repair work was begun by putting in steel piling in the form of a rectangle in the gorge below the blowout and piling into this cement masonry until the whole formed an enormous caisson which stopped the outward rush of the debris brought down by the stream. The sides of the canyon were then blown down on top and before this caisson and also on the up-stream face of the dam, a charge of several tons of dynamite being placed along the rocky sides and set off on November 19. There was a chance that the dam might be carried away by the million or more tons of rock which would be brought down by the blast; but the operation was completed successfully, the blowout was stopped up and the dam remained uninjured.

LETTERS DIRECT FROM THE PLANT

Cash Paid For Ideas Accepted. Sketches Desirable.
We Make The Drawings

Notes on Engine Repair

RECENTLY A 26 by 48-in. engine was leaking steam at the front cylinder head joint, near the bottom, and a machinist was sent on the job. The head was fastened to the cylinder by studs, the nuts of which just cleared the outside rim of the girder frame. The studs, by which the cylinder was bolted to the frame, screwed into the head and formed an inner row. The cylinder was loosened from the frame, slid back, and the head taken off. It was found that the action of the steam on the iron had eaten it away somewhat in places.

Two corrugated copper gaskets well white leaded were placed on the head; these were to fit on the original joint. Two more copper gaskets, larger in diameter, and just fitting within the circle of the outer row of bolts, were tied in place, with string, against the cylinder, and the head replaced. The cylinder was then connected to the frame, and a line run through. There was some surprise when it was found that the back end of the cylinder was high, about ¼ in. The grouting under the foot was cut away, and cylinder brought in line. It was then grouted with sulphur. When the engine started up, the leak had disappeared. The cylinder's being high at the back end, brought too great a strain on the bottom frame studs, and as the old gasket was in bad condition, the steam easily leaked through.

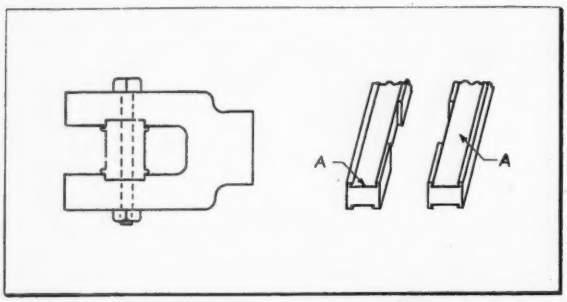


FIG. 1. CROSSHEAD OF HOISTING ENGINE

The main bearing box of an 18 by 36-in. engine ran hot, but was cooled off, and the engine ran for a few years afterward, and as the bearing gave no more trouble, or at least very little, it was never examined. Some time ago, this engine received a general overhauling, and the bearing was taken apart. The oilways in the quarter boxes were clogged with babbit, but otherwise had a bright appearance. One had to be rebabbited. The box contained a thick layer of babbit and was rough. We started to cut some oilways, when a layer of metal peeled off. Beneath it was smooth and bright; upon investigation it was found that a layer of babbit covered the original metal. It had been pulled up by the shaft, the time the box ran hot.

A direct connected Corliss in an electric light plant was giving considerable trouble; it made so much noise the people living near could not sleep at night. Another engine was being installed, and the erector was asked to try to help the noisy engine. It was found that there was play in the rod, main bearing, crosshead, and valve rods. This was taken up; but there was still a knock which occurred when the engine was on the back dead center. It was thought it might be the piston, so this was removed, rings taken out and examined, but it was all right; the bore of the cylinder was smooth, and in fine condition; so the piston was replaced. Still the pound. Next the metallic packing was taken apart and examined, and found to be all right. The erector was stumped for awhile. The steam valves were looked at, nothing there; but when 1/16 end play was taken out of the crank end exhaust valve, the engine ran like a watch. And to think that the knock had been telegraphed all over that engine, that one could imagine it was in bearing, crankpin, crosshead, or piston!

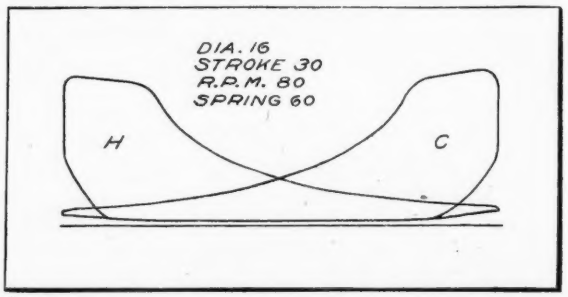


FIG. 2. CARD FROM OLD ENGINE WITH GRIDIRON TYPE VALVE

An 18 by 36-in. hoisting engine was fitted with cast-steel crossheads as shown in the sketch. The guides were flat bar type, of cast iron.

The engine ran but a short time before the guides were scored. Guides and crossheads were sent to the machine shop; guides planed, and crossheads planed and babbited, as shown at A. The slots in the crosshead were planed dovetail, and shallow holes drilled to hold the babbit.

The enclosed indicator card was taken from a gridiron valve engine, which has been in operation at least 25 yr.

TOM JONES.

Compound Feeder Problem

In his sketch showing the arrangement of his compound feeder Mr. Packingham states that with valve A partly open in the compound feeder line, water will be forced up into the barrel. At first this does not seem plausible, but I would account for it in the following manner:

With the water level at or near the top of the supply well, it would be above the level of the pump, and with the ¾-in. valve open, would be within 4 to 6 ft. of the barrel; therefore, only a few feet head must be overcome to force water into the barrel. With the pump working there will be a velocity in the suction pipe which will exert a pressure on the end of the ¾-in. pipe as the water makes a square turn at this point which will help to raise the water level in the ¾-in. line. In addition to this velocity head, the action of the pump, which is a single-acting machine, is intermittent; therefore, the supply of water going into the pump is not steady. When the pump is not taking water, the velocity of the steam in the 5-in. line adds more pressure to the end of the ¾-in. line and forces the water up into the barrel. This action is on the same principle as the hydraulic ram. The pump is getting its water under a slight pressure, depending upon the height of the water in the supply tank on account of the syphon in the suction pipe. With valve A wide open, the extra head due to the higher elevation of the barrel, will cause the water in the barrel to flow into the suction line during the suction stroke of the pump; but with the valve partly closed, the water cannot flow out as fast as it is forced in through the ramming action of the water in the 5-in. line. J. C. Hawkins.

A Dangerous Practice

An account of a boiler explosion in a certain engineering magazine and the opinions used as to its cause, remind me of a certain plant in a state where engineers aren't required to have a license, and I doubt whether the boilers were ever inspected.

In traveling through different parts of the country, a person will scrape acquaintance with a few engineers and on his next visit will naturally call on them again to renew the friendship. Having some time to wait in the place where this plant was located, I visited the engine room, there I found a new man in charge with whom I did not stop to talk, but walked through the engine room to the boiler room to see if the old fireman was still on the job. I found a new man in his place, who seemed rather inclined to talk of the great success he and the new engineer were having. I asked him if they were still carrying the 100 lb. the old engineer was carrying on the boilers. "No," he said, "we are carrying 120 lb."

As he had to tend his firing, I walked over and noticed the gages were still registering the 100 lb. When he came back I asked him if the gages were right.

"Yes," he said, "the new engineer set the valves to blow at 120 lb., then shifted the hands on the gages back on the 100, so as to make a better record than the other engineer."

In my opinion, those same boilers that the new man was trying to make a record with should have been allowed a pressure of at least no more than the old engineer was carrying, and here was a man endangering life and property to make a record, simply because there was no license law. Geo. W. Jacobs.

Know Your Plant

In the Dec. 1 issue, under the caption, "Know Your Plant," one readily recognizes the fact that the writer of this editorial has more than once cussed the night operator of his local telephone company, stumbled through the dark, hit that ingrown toe nail square against the rocker, and possibly rammed his nose against the door while his hands were feeling on either side of it. And after reaching the phone, croaking like a frog as he gives his night man the "how to do it," fighting to keep awake long enough to get back to bed, we know that he has been at one time a "chief."

But how true it is that an engineer should know his plant! And there are no end of little peculiar things in every plant that may be overlooked unless a man is practically in love with the plant. I know from experience that unless one can be practically in love with his plant he had better seek a job elsewhere. Also, I make it a rule to pet my machines, much as if they were alive, for to me there is nothing more friendly, more human, than a good old engine, faithfully plugging along, doing her duty day after day, and always at her best.

Also, I watch them as I would a child, giving a little more oil for the "stomach's" sake or a little less, as they need it. I always keep them dressed in a nice coat of paint, and their bright parts bright. If a bearing needs just a little tightening it gets just a little; if it needs something else it gets it.

Another thing I make a point of not doing is this. No matter how simple the trouble is, I never "jack a man up" for calling me; for I hold that, being chief and responsible for every result in my plant, no man but I, not even the owner, can lay hands on the work without my knowledge and consent. Another thing I do is this. I take my floor men, and in doing a repair job, or in fact, anything, as toward "fixing" a part of the plant, and let them see how I do it. I give them to understand that they are perfectly free to make any suggestions they think would be of benefit. If their suggestions are not good, I explain fully why they are not; if they are good I try them out, thus making the man feel that he also is a part of the establishment, and giving him a chance to learn all that may be learned in the plant where I may be at the time. I do not hesitate to allow them, under my observation, to take hold and do the job themselves the next time it comes up, and so in time they get to know as well as I, just what is wrong, and what is needed. So that when I finally reach the phone in the dark, and one of my men tells me that such and such a thing is wrong, I know that he knows pretty much whereof he speaks, and so I can more clearly tell him what to do as regards the matter. Also, by this system the men take more pride in their work, and in co-operation with their chief they come to "know their plant." John Pierce.

Compound Feeder Problem

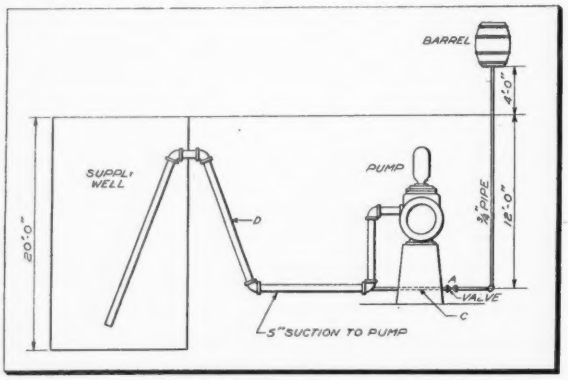
IN REGARD to "Compound Feeder" problem by R. M. Packingham, page 1198, December 15 number:

The phenomenon may be explained by referring to the principle we have in the hydraulic ram. The pump in question having only one water cylinder, at the end of each stroke the water in the suction pipe comes to rest with a sudden increase in pressure, due to the kinetic energy it has in virtue of its speed. For a more complete explanation, the law of conservation of energy may be applied.

This kinetic energy is expressed in the formula,

$$K.E. = \tfrac{1}{2}\, m\, s^2,$$

in which m is the mass and s is the speed of the mass in motion. By referring to the formula, we see that, the mass remaining constant, the kinetic energy increases as the square of the speed. By reason of this a moderate



PIPING TO PUMP AND COMPOUND FEEDER

speed may exert a comparatively great pressure. This pressure will cause water to flow out through the feed pipe, C, until pressure in C equals pressure in suction pipe. If a check valve be placed in pipe C to retain the water when the pressure in D falls, the barrel will fill, as it did with Mr. Packingham.

From Mr. Packingham's explanation, I would infer that valve A is a globe valve with a loose disc, the disc acting as a check. With a disc tight on the valve stem, I do not believe the barrel will fill.

A bypass around A could be arranged with check and globe valve to fill the barrel. J. B. WALKER.

A Sawmill Plant

IN THE December 15, 1913, issue of Practical Engineer, appeared an article, entitled "What the Young Engineer Did," stating that the Kid Engineer described came from the sawmill. Now, I shall describe a modern sawmill plant; then see if anybody thinks a Kid Engineer could handle a plant of this kind.

This plant is located at Winton, Minn. Albert Cornell is chief; the writer was first assistant and Chas. Fox, second assistant.

The boiler plant consists of 5 72-in. by 18-ft. return-tubular boilers with a working pressure of 125 lb. to the square inch. These are manufactured by Wm. Bros & Co., of Minneapolis, Minn. The dampers are controlled automatically. Water columns are of the Wrights high and low water alarm type. The boilers are set in 2 batteries with mud drum connection at the bottom. Dome connections at top have suitable headers with stop valves. The fuel consists of sawdust, fed by a conveyor, under control of fireman, into Murphy furnaces of the dutch-oven type.

The feed water is supplied by a duplex pump of sufficient size to supply the boilers at a speed of 10 to 15 strokes per min., supplemented by a Cameron pump No. 5, which is also connected into the water line of the fire pump, an Underwriter's pump with a rated capacity of 750 gal. per min., at a speed of 70 strokes per min. All of these pumps are controlled by Fisher pump governors.

The main engines are of the Filer and Stowell Corliss type, 24 by 36-in. twin engines, run at a speed of 95 r.p.m.

The lights are supplied by a Westinghouse d.c. generator, rated for 220 volts and 180 amp., 975 r.p.m., belt connected to a Buckeye engine, 12 by 16 in., at 185 r.p.m.

The filing room machinery is operated by a Nagle engine, 10 by 12 in., handled by the filing room man.

Auxiliary machinery in the mill consists of one steam feed cylinder, 12 in. in diameter by 24 ft.; one steam feed cylinder, 12 in. in diameter by 34 ft.; 2 steam niggers, 2 steam log loaders, 2 steam flippers, 2 steam guide lifters, 2 steam kickers for removing lumber from the rollers, one steam lumber trimmer to lift saws, an automatic sprinkler system of the wet type, a sprinkler system on the roof to cool the mill and all of the electric lights and circuits are under control of the engineer.

Do you think a plant of that description turns out any kid engineers of the kind described?

After several years' experience as a sawmill engineer, I will say that the majority of up-to-date sawmill plants compare favorably with this one described, and nearly all up-to-date sawmill engines are of the 4-valve type. I fully appreciate the moral in the article referred to, but object to having it refer to sawmills in general.

FRANK M. JOHNSON.

Proper Location for Pump House

THE QUESTION asked in regard to the above subject by W. H. P. and answered by A. L. R. in Dec. 15 issue, page 1201, may be sufficiently correct with the information given; but the writer desires to express his views on the question. W. H. P. says the point he can't see is, what has the location of the pump house to do with low water? The location of the pump house has nothing to do with low water, but low water has a great deal to do with the location of the pump house. The center of pumps should be placed so as to have not over 25 ft. of suction lift including friction when river is at low water; and, better still, if placed so they have no lift at all. River water contains considerable air and with long suction pipes more or less air leaks in, which decreases efficiency of the pump, at the same time reducing its capacity.

Concrete is excellent material for building intakes and can be made water tight; therefore, I should be in favor of placing the intake (or pump house) as near low water as possible and building it sufficiently high to prevent flooding during spring high water. L. K.

Priming A Centrifugal Pump

IN REGARD to O. H. Peterson's article in Dec. 1 issue, from my experience with centrifugal pumps, it is my opinion that some designs of pumps will accumulate air in the impeller until they lose the suction, while with others the air is carried out with the water as fast as it enters, if it does not come in too large quantities.

Mr. Peterson asks whether, if there is a column of water in the ¾-in. pipe 18 ft. high, above the pumps (maintained by the dry vacuum pump), he will have a head of 18 ft. on the suction side of the circular. The height of water in the ¾-in. pipe does not affect the suction side of the circulator, as that is governed by the height the center of the pump is above the source of supply and the friction loss in suction pipe.

For instance, suppose the water is at low water level and the center of the pump is placed at the same level, the height in ¾-in. riser would be practically the same as in the preceding case and the head on suction side of circulator would be only the friction loss in suction pipe; therefore, the height of water is not an indicator of head on the suction side of the circulator.

I think the arrangement is a very good idea.

LAWRENCE KJERULFF.

Convalescing

I SUPPOSE that the engineers will be wondering if the old gent has died. Well, I have felt about that way for several weeks but at the present instance I can say like the Dutchman, "I can sthand oop in der bed, und gomblain dot I vos betters."

Tuesday, I was up at the Fish Bros. plant making a simple engine out of a cross compound that wasn't built for it and without melting it over again. Someone had been monkeying with a monkey wrench and such a valve gear I never saw. One knockoff rod was bent so that it was nearly broken off.

Then I went back to the south works 2 days and then one of the high-speed tandem compound engines in the downtown central powerhouse got on a rampage, and Friday and Saturday I was up there, and am there yet, and liable to be for some time unless I can induce the piston rod to come out of the low-pressure piston without resorting to the hacksaw.

So just these few days seem to be beneficial to my roomatics for some reason or other.

The engine is 13 by 20 by 16 tandem, 250 r.p.m. with steel mixture rings pinned to the pistons. Those pins did the mischief.

They broke off in the low-pressure cylinder and got wedged into the groove with the snap rings and the way they made a washboard out of that cylinder was a caution. Well, it means reboring, as the little pin had worn sort of eccentric and when the piston started to reverse on the head end, the eccentric pin raised it up as far as the bore would let it and tried to go further.

The horsepower is tied up to the steam main, yet sets on a pedestal, not being bolted to the foundation plate as a good cylinder ought to be. The distance piece was in halves, theoretically, but it was like breaking a will to get them apart.

With this fixture out, there was only 19 in. for clearance and when 2 cylinder heads, each with metallic packing sticking out like a mail box on them, and the low-pressure piston 7 in. thick get into this space, there is no room left for anything but cuss words.

To get the low-pressure cylinder off the piston rod has got to be driven through the low-pressure piston and out through the front end, necessitating the removal of the connection rod and cross head. Fine business.

I guess the piston is soldered on the rod. I have it up against the front head and 2 pieces of 1¼ by 4 steel across the frame edgeways, and the jam nut screwed down on that trying to draw the rod out of the piston. I figure that there is a 50-ton strain on it with a big wrench and a 9-ft. pipe on the end, but I left it drawn up tonight, and soaked it in kerosene till morning. I also shut the door so that if it did get off it couldn't run at large upon the streets, alleys and boulevards of the city.

So, if the cussedness of that engine holds out, I expect to regain my normal health again.

The turbines at the south plant are running, that is, noncondensing as the last storm has filled up the intake well 2 ft. above normal water level with sand, and there we are, pumping it out with that sand sucker.

G. H. WALLACE.

Valve Location; Drinking-Water Pump

UNDER THE caption, "Position of Valves on Steam Lines," in the Nov. 15 issue, I find a very sensible argument, with one exception; even this exception may be sensible enough if I only understood it. Mr. Hawkins states that the laws of Indiana calling for "a valve within 18 in. of the boiler" is a dangerous law, meaning, of course, the practice and not the law itself.

Now, what I'm worried over is this: "Why is it dangerous?" What danger is there in a valve only 18 in. from the boiler any more than there would be were the valves 24 in. away? Will Mr. Hawkins kindly state the reasons as to the danger? Accidents will sometimes happen even to automatic devices, and so we must expect imperfect man to blow himself up once in a while.

Under the caption, "Furnishing Drinking Water," P. H. says that "a thousand feet of pipe and a little head work are all that is necessary." As long as he had to pipe water to the factory from the feed pump, in order to get a motive power for his device, why not simply build a tank, and then use the feed pump to fill the tank? Why not take the exhaust from his water motor to his main pump suction and save pulling this water from such a distance?

JOHN PIERCE.

FRANCIS S. PEABODY, president of the Peabody Coal Co. of Chicago, recently gave a lecture before the College of Engineering of the University of Illinois on "The Mining and Utilization of Illinois Coal." The lecture was illustrated with excellent motion pictures taken underground in actual coal mines. They are the first successful motion pictures taken underground, and they give a vivid idea of the actual conditions met in coal mining.

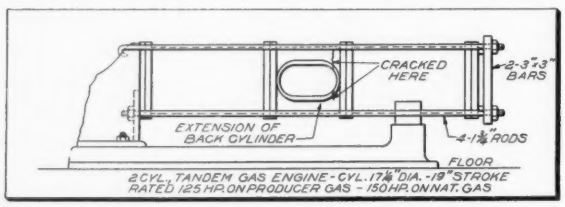
Successful Kinks From The Plant

For Saving Time, Work and Trouble

Repairing a Gas Engine

ACCOMPANYING SKETCH shows the manner in which we reinforced our gas engine which had developed cracks in the extension neck connecting it to the crank cylinder.

These cracks, as shown, cross the 2 ribs on both sides of the cylinder as well as along the angle of the opening to the rod packing; they are probably due to contraction of the outer walls of the jacket, but as they lie mostly in the distance piece between the cylinders they undoubtedly weaken the engine and without the support of the 4 1¾-in. rods would probably extend.


CRACKED HERE
2-3"x3" BARS
EXTENSION OF BACK CYLINDER
4-1¾" RODS
FLOOR
2 CYL. TANDEM GAS ENGINE - CYL. 17⅞" DIA. - 19" STROKE
RATED 125 HP. ON PRODUCER GAS - 150 HP. ON NAT. GAS

METHOD OF REPAIRING GAS ENGINE

The load thrown on the connections between the 2 cylinders would not likely be greater than 40 tons, 234 sq. in. piston area multiplied by 350 lb., greatest explosion pressure the indicator has recorded on this engine. The 4 1¾-in. rods should have a breaking strength of about 360,000 lb., which gives a factor of safety of roughly 4½, which, in addition to the strength of the uncracked portion of the neck, should hold the parts rigidly together. We watch the cracks, of course, to see that they do not extend, and the wrought rods would hardly give way instantaneously as with cast iron. The fellow who said that a gas engine was a machine for rotating a shaft by shooting a cannon at it had the right idea of the proposition. It is almost impossible to make the parts strong enough to stand the shock of the explosion for any great length of time and it is just as hard to design the firing end so it will stand up to the strains of expansion and contraction.

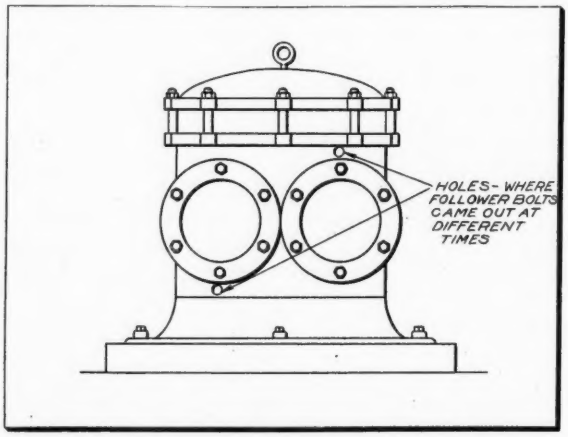
I have had quite a number of years' experience with engines of medium size, and good luck with them; I have found them reliable motors, but believe they will shoot themselves to pieces in the end.

While we were getting the material ready for the repairs described above, we operated about ¾ of the machines with the crank cylinder, disconnected the exhaust pipe of the dead cylinder from the header and plugged the latter, blocked the exhaust valve open, removed the lifting rocker from the inlet valve, so it would stay shut, and disconnected the magneto wires from the spark plug, regulated the air and gas by the throttle (the governor valve opens once for each cylinder in a cycle of the 2 cylinders), and got along fine except that the air rushing in and out of the dead cylinder made the engineer sick, and by the time I had finished the run for him I felt quite ill.

I think patched-up engines look bad, at the same time I don't think we shall order a new cylinder if the present one shows no further weakness. J. O. BENEFIEL.

Pump Repair

I AM sending a little sketch of a repair job I was called to do in a brewery. It was the water end of a duplex pump used for brine circulation, until the first bolt came through the top of the cylinder. Then it was sent to be welded; but there was no life left in the iron, so it didn't hold. I took out the metal put in by the welding company, which left a hole ¾ in. in diameter. I cleaned the hole well with raw acid, then washed it with water and tamped the hole full of Smoothon iron cement. After the cement was set the pump was used to pump water to the cooling tower until the second



END VIEW OF PUMP, SHOWING WHERE BOLTS WENT THROUGH THE CYLINDER

follower bolt came through the bottom of the other cylinder, which was repaired in the same way. The iron in this pump was so rotten that you could take a ¾-in. drill in a brace and drill it the same as you would a pine plank. I suppose that is the reason why the pump wasn't damaged more, but I have never been able to figure out how the bolts came through where they did.

B. C. WHITE.

WHEN ANYONE has offended me, I try to raise my soul so high that the offense cannot reach it.—Descartes.

NOTHING WILL EVER be attempted if all possible objections must be first overcome. —Dr. Johnson.

Questions Answered and For Answer

Expert Help When In Trouble. If You Want Quick Answer Enclose a Stamp

Shaft Governor Questions

WITH A shaft governor, on single-valve engine, can a loose eccentric be used?

2. How would you proceed to set the valve of a single-valve engine with shaft governor, using a slotted eccentric?

3. What position would your governor weights occupy while setting it?

4. What is negative lap, and where is it used?

M. B.

A. Single-valve engines with a shaft governor must necessarily have an eccentric which is not fixed in one operation, as it must be moved by the governor with every change of load and pressure in order to maintain regulation. A few engines have the cutoff eccentric with a fixed radius of eccentricity, but loose on the shaft so that the governor can rotate it around the shaft with every change of load and pressure.

However, practically all high speed engines using a shaft governor and a single valve, have the eccentric attached to a swivel pin located at a certain point in the flywheel, to which is also attached the governor, and while the eccentric is loose, in a sense, all of its movements as promoted by the governor must be made with the swivel pin as the center.

2. In setting a single valve with a shaft governor, it must be borne in mind that all the events of the cycle are performed by one valve which is designed so as to strike a medium between the several difficulties that are presented in trying to obtain good results under all operating conditions.

The travel of the valve is fixed by design, and the eccentric being attached to the flywheel (or a wheel for that purpose sometimes) cannot be advanced or retarded, unless the entire wheel be advanced and retarded also, which would mean making an offset key to suit the new conditions.

With these things in mind when setting this kind of a valve, all you can do is so to adjust the valve on the valve stem, that it travels about equally at both ends.

3. Ordinarily all that is necessary to do, is to let the governor remain in its position of rest, or full throw, and adjust the valve so that you have the same amount of lead at each end. If you know your engine and the operating conditions, with a little care, you can, by means of a pipe jack (or any other method that your ingenuity might suggest), block out the governor to that position where the cutoff will take place at, say, 22 per cent of the stroke, which you have found to be the point where the bulk of the load is carried.

Then, as the load increases or decreases, you will begin to depart from the most ideal conditions, but you have the valve set where it will be the most economical the most of the time.

In some forms of governors, the lead remains constant when the load and pressure changes, while in others the lead either increases or decreases when the load and pressure change. If the angle of advance only is changed, the cutoff and the lead are changed; if the eccentricity is changed, leaving the angle of advance unchanged, the same trouble is experienced, only in an opposite direction.

That is, when the angle of advance only is changed, decreased cutoff means more lead, and when the eccentricity only is changed, increased cutoff means more lead. The effort of every single-valve automatic engine builder is to effect a combination of these 2 conditions so as to get a variable cutoff and still maintain a constant lead.

4. Negative lap is, in other words, port opening, with the valves in central position, and "hooked up," and is used on double eccentric Corliss engines with a long range valve gear. On a double eccentric Corliss engine, the eccentric handling the exhaust valves is located practically in the same place as it would be were the engine equipped with but one eccentric to operate all 4 valves, if the motion is direct.

But the prime object of the double eccentric engine was to increase the point of cutoff from the limits of about 45 per cent, as in the single eccentric engine, up to as late as was possible, or to that point where the steam valve would just be closed immediately before the exhaust valve at that end released.

To secure these results, the steam eccentric was set back a little and the lap (in central position) was reduced. This was seen to be a step in the right direction, so the good work went on and the eccentric retarded still more with a corresponding reduction in the lap till a point was reached where there was neither lap nor lead in the central position.

Further experiments revealed the fact that the steam eccentric could be set back till it was about 35 per cent, or so, ahead of the crank, at which point it was found that cutoff took place at about 80 per cent of the stroke and at this point, with the valves in the central position, instead of having lap on the valves, as was the case with a single eccentric, they had port opening, or, as it is sometimes called, negative lap. An engine with negative lap and a long range cutoff, must have the knockoff cams so adjusted that the valves will not "carry" at any time, but will trip when the engine is first started; otherwise, the late steam eccentric would hold the steam valve open at any given end till the exhaust valve at that end had opened, thus letting steam blow right through the engine into the exhaust.

G. H. WALLACE.

Impractical Compressed Air Transmission Scheme

WE HAVE 2 lakes from which we are pumping water. At the main station we have an air compressor of 1170 cu. ft. capacity. At the lake a mile away we have a 10 by 10 by 12-in. steam duplex pump and a 4-in. air line connecting the 2 plants. The above pump is now driven by steam and as we need this boiler for other purposes, I would like your opinion as to running this pump with compressed air. If we can, it will save hauling coal and the time of licensed engineer, as we will use this plant only about 3 mo. or until we get our electric-drive pump running. Will this pump freeze up? The head it will have to work against is about 45 ft. and the compressor is built for 60 lb. C. E. G.

A. I regret to say that your scheme does not seem to be practicable. The pump dimensions as given are not intelligible to me, so that I can only offer a crude estimate from the compressor end. The apparently fatal objection at the beginning is that the 4-in. pipe line is too small.

The formula for the loss of air pressure in pipe transmission (Richards' Compressed Air Practice, 1913, page 147) is:

$$p_1^2 - p_2^2 = \frac{v^2 l}{2000\, d^5}$$

Here p_1 is the initial absolute pressure in pounds per square inch, p_2 is the terminal absolute pressure, v is the volume of free air in cubic feet per minute, l the length of pipe in feet and d the diameter of the pipe in inches. By this formula, with the compressor capacity and other data as given, we have:

$$\frac{1120^2 \times 5280}{2000 \times 4^5} = 3234$$

Then $(60 + 15)^2 = 5625$, and $5625 - 3234 = 2391$ $\sqrt{2391} = 48.89$ and $75 - 48.89 = 26.11$ lb. absolute, or $26.11 - 15 = 11.11$ lb. gage terminal pressure.

With a 6-in. pipe and all other data unchanged, the terminal gage pressure, computed as above, would be 57.11 lb., a loss of 2.89 lb., while with an initial gage pressure of 90 lb., the loss would be only 2.05 lb.

In general compressed air practice, higher pressures should be used, both for easier transmission and for the more advantageous employment of the air when delivered. If there is any low spot in the pipe at some considerable distance from the compressor, where the air has entirely cooled down to the temperature of its surroundings, there should be some pocket or enlargement provided in which the water could settle to be drawn off at regular intervals, so that it would not be forgotten, and there should then be little or no trouble from the freezing up of the exhaust.

Air is not to be advocated for the driving of direct acting steam pumps except for convenience or safety, and for this service the remarks favoring high pressure air do not supply. Low pressure air, and cylinder proportions calling for low pressure air, are most economical. Reheating the air as near as possible to the pump, accomplishes a considerable saving and it applies here because the air is used with a steady flow, while the intermittent use of the air in rock drills and the like, make the reheating impracticable.

Although, as was said at the beginning, the dimensions of the pump inquired about are not in usable shape, it may be certainly said that the steam cost of operating with air furnished by a steam-driven compressor would be greater than when using steam from a boiler located near, but the air would do the job all right. F. R.

Firing With Wood

I AM about to change my position and am going to have a boiler in my care which is fired with wood. This is a factory which makes step ladders, bent felloes, club-turned spokes, hub blocks, etc.

I can't give you size of boiler, but as I have never fired with wood I would like to have your instructions on how to handle boiler with wood for fuel. Also explain how to bank the fire. W. T. Q.

A. In regard to the firing of a boiler with blocks and sawdust, this is usually a problem which requires considerable individual study of the plant, as the fuel varies so much in proportions of blocks, shavings and sawdust.

I take it that your plant has been arranged for wood burning, so that you will not have the problem which sometimes comes up when a coal-burning furnace is used for wood burning. In that case, it is usually necessary to cut down the grate area. In one instance, a grate was cut down from 8 by 8 ft. to 3 by 8 ft., in order to get the best results. This was accomplished by putting an old boiler plate on the back of the grates and covering this with ashes to prevent overheating it.

The burning of wood or waste calls for a big furnace and a thick fuel bed. Usually this is fed through chutes from above, and the fuel should be left to pile from 3 to 4 ft. high under the chutes. Each chute will take care of from 30 to 35 sq. ft. of grate under these conditions. A strong natural draft is needed and will be better than a forced draft, as the blast will usually blow unburned fuel over into the combustion chamber and tubes.

The fires should be disturbed as little as possible. One hundred fifty pounds of fuel can be burned per hour per square foot of grate, if it contains 30 to 40 per cent moisture. If your fuel is waste from kiln-dried lumber, it will not contain so much moisture as this, and a somewhat thinner fuel bed can be used and a higher rate of combustion secured. Under these conditions, 1 sq. ft. will give from 5 to 6 boiler horsepower.

As a good deal of half-burned fuel and ash is carried over by the strong draft, it is necessary to clean the heating surfaces often. If the fuel is green, it will generally be necessary to burn some coal with it, and the fire is usually banked with coal or with wet sawdust.

A. L. R.

Proper Back Pressure

HOW WOULD you proceed to find the amount of back pressure necessary to make your engine run smoothly?

L. F. S.

A. Suppose that your engine does not run as smoothly as it ought to and you desire to remedy the defect. Do not, by any means, do any adjusting until you are sure what you want to do and are satisfied that you are on the right track.

The only way to make any adjustments on the valve mechanism of any kind of an engine is first to apply the indicator, and then act accordingly.

If the engine is not running smoothly, see what the card says, and if it is a question of compression, make the necessary adjustments and indicate till you secure the desired results.

Back pressure is not a permanent factor in engine operation, as many engines operate under none at all, and even run condensing where practically all of the absolute back pressure is removed, and again engines run under a back pressure as high as 10 to 20 lb. and even 45 lb., yet these engines can be made to operate as smooth as can be desired. G. H. WALLACE.

Bituminous Gas Producer

WHAT KIND of a gas producer (bituminous) should be used for 40-hp. gas engine? How would you figure the efficiency of gas producer and gas engine?

W. M. K.

A. Such a producer has not been made yet. Tar troubles render gas from soft coal unfit for engine use. Hard coal only is adapted for use in so small a producer. Scrubber systems are too elaborate for use with small producers.

I understand the overall efficiency of producer is required. Measure output of engine at flywheel by friction brake. Get results in horsepower and multiply by 2545 to reduce this to heat units. This is the output.

Weigh coal fired to producer in pounds. Multiply this by heat value of coal per pound and the result is the number of heat units put into the plant in any interval of time.

Output in heat units by brake divided by heat units fired in the same period of time is the efficiency.

J. C. MILLER.

Converting a Boiler Into a Heater

WE HAVE 2 boilers which we do not use for steam any more and wish to convert one of them into a water heater. Would you advise us how to repair them so as to make good heaters, and which one of the 2 would you use? One is 40 in. by 12 ft., the other is 48 in. by 14 ft. We have a 150-hp. boiler, 150-lb. working pressure.

S. M. C.

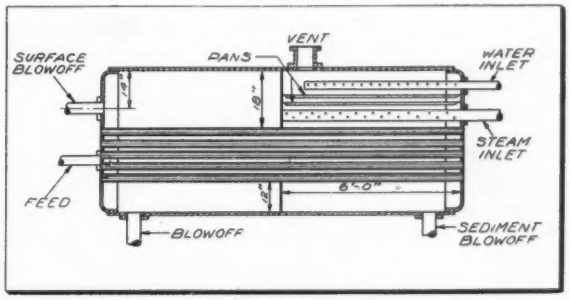
A. It would be possible, from one of your old boilers, to make either an open or a closed heater.

In the case of the closed heater, it would probably be best to send your exhaust steam through a coil of piping put inside the boiler, and let the water into the boiler shell at the top, and draw it out about 10 in. from the bottom, at the opposite end. This would give a chance for the deposit of any sediment in the bottom of the boiler shell, where it could be drawn out from the old blowoff.

There should be about ⅓ of a sq. ft. of tube surface for each boiler horsepower. The coil inside can be made up of return bends and straight lengths of pipe, passing back and forth from one end of the boiler to the other; the steam preferably entering at the bottom, and passing out at the top, with a drip at the inlet to take out condensed steam.

If you prefer the open type heater, I would suggest an arrangement as shown in the sketch. The water comes in at the top of the boiler in a pipe, say, 1½ in. in diameter, with holes drilled in the sides so that the water squirts out in sprays onto 2 pans. From these, the water runs over the edges and falls down in sheets.

The exhaust steam comes in also through a perforated pipe, passing out in jets which mingle with the feed water. In the middle of the boiler shell, plates are put in—one coming up from the bottom, the other hanging from the top. The top plate supports one end of the steam inlet, one end of the water inlet, and one end of each of the pans. The water will pass downward in the compartment at the right, then from the space



PLAN FOR MAKING HEATER OUT OF BOILER

between the plates to the left-hand compartment, and is drawn off through the feed outlet. Sediment can thus settle out of the water in the right-hand compartment, and be drawn off by the blowoff and be prevented from passing to the left by the bottom plate.

Scum and oil will have time to rise to the surface in the left-hand compartment, and can be drawn off by the surface blowoff. Also, any additional sediment or scale-forming material will settle in the left-hand compartment, and could be taken out through the left-hand blowoff.

Boiler tubes could be left in place through the space between plates, and plugged at each end. The tubes could be taken out at top and bottom, where they would interfere with the plates, and the holes could be filled with pipe plugs. A. L. R.

Difference Between Centrifugal and Inertia Governors

WHAT DO you understand to be the difference between centrifugal shaft governors, and the inertia governor? How does each perform its operation? E. M.

A. In order to give an intelligent answer to this question it is first necessary to understand the true meaning of the terms, inertia and centrifugal force.

Inertia is that property of matter which tends to keep it at rest, if in a state of rest; or if the matter be in motion its inertia tends to keep it moving. Centrifugal force is the force which causes a body to fly from a center, around which that body may be revolving. A centrifugal shaft governor acts mainly through the centrifugal force of the heavy weights attached to the free ends of 2 arms or levers, while the other ends of the levers are connected by means of pins to opposite arms of the governor wheel.

These levers or weight-arms swing upon the pins, and as the speed of the engine shaft increases the centrifugal force tends to move the weighted ends away from the shaft. This force is partially counteracted by springs attached to the arms. The eccentric is loose on the shaft, and is connected to the weight-arms in such a manner that the outward motion of the arm moves the eccentric slightly ahead, thus increasing the angular advance and causing an earlier cutoff to take place.

Should the speed of the engine slacken, an opposite movement of the weighted arms and the eccentric, will cause a later cutoff. Inertia shaft governors usually consist of a single bar pivoted at or near its center to an arm of the governor wheel, and so shaped that, while its center of gravity falls not far from the shaft center, the bulk of its mass is at or near its 2 ends. As this bar rotates with the shaft, its inertia tends to keep it rotating at a uniform speed. If the speed of the engine shaft slackens, the inertia of the governor arm causes it to run ahead of the shaft, and carry the eccentric with it, in this case giving a later cutoff; or if the engine speed increases, inertia tends to retard the governor arm and the eccentric which is attached to it. Both types of governor regulate the speed by varying the point of cutoff.

Questions on Link Motion

How can I set a slide valve on a double eccentric reversible link gear valve, and how can I tell whether the rods are crossed or open?

2. Will an injector lift water as high as a pump?

3. On a reversible engine, cutting off at ¼ stroke, does it make release earlier than at ½ stroke?

4. With a Stephenson link motion, does the valve have more lead when the lever is in the corner than when it is almost on center? And is the valve travel the same when lever is at first notch as when at last notch?

E. P.

A. With the reversing lever in the end notch either forward or back, see that the valve stem and eccentric rod are of the right length to give the valve equal movement both ways from the central position. Then with the engine on the center, set the valve just as though it were a single eccentric engine, paying no attention whatever to the other eccentric.

When the first eccentric is set, proceed in the same way with the second, trying the work with the reversing lever in full gear, both forward and back. A little final adjustment may be necessary after both eccentrics are made fast.

In all Stephenson link motions the eccentric rods cross during some portion of each revolution. If this crossing occurs when the engine is on the forward center position of the link, the rods are said to be crossed, and the lead of the valve will decrease as the link is hooked up. If the rods cross with the crank on the back center, they are said to be open and the lead will increase as the link is hooked up. This was fully explained in the issue of Aug. 1, 1913.

2. A perfect pump will draw water from a greater depth than an ordinary lifting injector, but the ordinary lifting injector will draw water from a greater depth than the ordinary pump in ordinary working condition.

3. With the link hooked up for a cutoff at ¼ stroke, release will occur at about ¾ stroke.

4. The first part of this question is answered in No. 1. The valve travel decreases with crossed rods as the link is hooked up. F. L. J.

Lead of Small and Large Engine

If 2 engines run at the same speed, but one is twice as large as the other, would you give the steam valve the same amount of lead? If not, why not? P. D. M.

A. Usually the large engine has a greater lead than the smaller one. The reason for this is, that the large engine, running at the same speed of revolution, will, of course, have a higher piston speed on account of the longer stroke. If, on the other hand, the same piston speed is maintained—which is more common practice—we have the volume to be filled proportional to the square of the diameter.

The length of the port across the cylinder is usually made a certain percentage of the diameter, so that to get the same rate of flow of steam into the cylinder through the port, we must increase the port width. Consider this point. If the same amount of lead is to be given for a big engine as for a small one, why not make the port width the same for the 2 engines?

A. L. R.

Examination for Third-Class Engineer's License

The following questions were asked at an examination for a third-class engineer's license in Massachusetts:

First, I set the valve on a common slide-valve engine with a straight rocker arm. It took me a long time, owing to the fact that the piston had been screwed out of the crosshead so much that I could not get past the head end center until I had equalized the clearance between the piston and heads. Then I loosened the set screw in the eccentric and tried to turn it around on the shaft to see the travel of the valve over the ports, so I could square the valve. The eccentric could not be turned on the shaft until I removed the eccentric rod. I then saw that the eccentric strap had been tightened up so that the eccentric could not be moved while the rod was in place. I loosened the strap, squared the valve, put the engine on the center, and gave her lead about the thickness of a knife blade, turned her over to the other center, and found the lead a little greater on the crank end, so let her go at that. Next, set the valves on a duplex pump by putting everything on central position and equalizing the last motion.

The inspector invited me to sit at his desk then and asked me these questions:

1. Why do you give lost motion between the valve and valve rod when setting the valves on a duplex pump?

2. Would you block up tight under the mud drum of a B. & W. boiler?

3. How about the Stirling boiler?

4. Why are the tubes of the B. & W. boiler on an incline?

5. Why not in the Heine?

6. What is the difference between the centrifugal and inertia governors?

7. What is the meaning of inertia?

8. Why are cylinders bored larger at each end?

9. How would you find the clearance?

10. Suppose the piston rod was a taper fit and keyed in the crosshead and the crank and crosshead boxes are of the gib and key type, what is the gib for?

11. Why is it tapered?

12. What is the difference between a solid and built-up piston?

13. Where would you measure from to center the piston?

14. What is the ogee ring for, on a Manning boiler?

15. Which of the 2 plates in the water leg is the thicker?

16. Where do stay bolts fail?

17. What do you know about the Fitchburg engine?

18. What type of governor has it?

19. What kind of valves has it?

20. Suppose the valve were leaking, what would you do?

21. When would you do it?

22. How would you know they were not too tight?

23. If one of the valves was loose from the valve gear and left open, what would close it?

24. How can you tell that an engine with a shaft governor will not run away, without taking the valve chest cover off?

25. If there was end play, what would you do?

W. B. C.

Heating Surface Required

REFERRING TO A. L.'s problem, page 175 of the Jan. 15 issue; in order to determine the amount of pipe needed as heating surface for this space, we will need to calculate the heat loss through windows and walls, and the loss which is entailed by leakage of air in and out of the heated space. Experiments have shown that the loss of heat through an ordinary wall is approximately ¼ B.t.u. per square foot per hour for each degree difference between the inside and outside temperature, which in this case is 80 deg., so that the heat loss per square foot per hour would be $\frac{1}{4} \times 80 = 20$ B.t.u. The loss through single glass surface is given as 1 B.t.u. per degree difference, which multiplied by $80 = 80$ B.t.u. per square foot per hour.

Now the glass surface would be $14 \times 8 \times 24 = 2690$ (nearly) sq. ft., which multiplied by $80 = 215{,}200$ B.t.u. heat loss, and the wall surface would be $(130 \times 11.5 \times 2) + (110 \times 11.5 \times 2) = 5530$ sq. ft., from which we subtract the window surface $(5530 - 2690)$, giving 2840 sq. ft., and multiplying this by 20 B.t.u. gives us 56,800 B.t.u. loss from wall surface.

For the roof we will assume a coefficient of 0.14 B.t.u. loss per hour per square foot per degree difference in temperature, so multiplying together the square feet room area $(110 \times 130 = 14{,}300)$ and 0.14 and 80 we get 16,000 B.t.u. heat loss. If there is no space between the ceiling and roof use a coefficient of 0.24.

For leakage, we will assume one change of air per hour, which is conservative for a well-built building. The volume of air then to be heated would be the volume of the room or $130 \times 110 \times 11.5 = 164{,}500$ cu. ft.

Now, the specific heat of air is about 0.237 and a cubic foot of air weighs 0.08 lb., so that the amount of heat which would be used per hour to heat the air would be 0.237 B.t.u. $\times 0.08 \times 80 \times 164{,}500 = 249{,}500$ B.t.u.

Adding these together, we have $215{,}200 + 56{,}800 + 16{,}000 + 249{,}500 = 537{,}500$ B.t.u. total loss.

Now, the heat given out by wrought-iron pipe in which steam is supplied at 10 lb. pressure is approximately 300 B.t.u. per square foot per hour, so that the radiation needed would be $537{,}500 \div 300 = 1791$ sq. ft.

It would be well to add 10 per cent to this for quick heating, which would make $1791 \times 1.10 = 1970$ sq. ft.

One running foot of 2-in. pipe gives 0.622 sq. ft. of radiating surface and one foot of 1½-in. pipe gives 0.494 sq. ft., according to table in "Ideal Fitter" of American Radiator Co., so for 2-in. pipe $1970 \div 0.622 = 3170$ ft., and for 1½-in. pipe, $1970 \div 0.494 = 3990$ ft.

The volume of steam at 60 lb. pressure = 5.8 cu. ft. per pound, and this volume, multiplied by pounds of steam used per hour, will give us the volume which will need to pass through the 2-in. pipe per hour.

A square foot of radiation will condense about ⅓ lb. of steam per hour, so that $1970 \div 3 = 657$ lb. would be needed per hour, or $657 \div 3600 = 0.1825$ lb. per second. The volume of this steam would be 5.8×0.1825 or 0.106 cu. ft., which divided by a velocity of 50 ft. = 0.0021 sq. ft. and $0.0021 \times 144 = 0.3024$ sq. ft., which is the area of a ⅝-in. circle or ¾-in. pipe. This shows that your 2-in. pipe is plenty large, and a smaller pipe would do just as well unless the distance should be very long.

S. E. B.

RECENTLY A BILL was passed by Congress granting to San Francisco and other cities thereabout the right to flow the Hetch Hetchy Valley, which is a part of the Yosemite Park tract, for the purpose of creating a water supply reservoir, and right of way through national parks and forests for pipe lines and transmission lines for a large power development. Now a bill is before Congress for the repeal of this grant, on the grounds that it was made under a misunderstanding, that undue influence of lobbies and unfair means was exerted, disregarding the public welfare, that this diversion of the waters of the Tuolumne River will leave 200,000 acres of fertile land without adequate irrigation, that none of the cities except San Francisco want or will accept the privileges of the grant, that the grant permits storage of 10 times the water needed for 100 yr., and that influence was exerted for the bill, not because of its merits, but to establish a precedent for Federal encroachment on state rights in control of distribution, sale and use of water and electric power. Further, that this use of the valley will bar the public from a great tract that is now used for recreation and summer camps.

So far as balancing a playground reservation against a great development of power which is now going to waste, economics would seem to point to substituting other tracts which do not interfere with power development for those needed for the reservoir. On the political question of the method by which the grant was obtained, the "square deal" seems the fair deal, and it is to be hoped that any hasty or biased action will be reconsidered to allow a "full, fair and impartial investigation.

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Organization and Administration

In the power factory or power plant, the same problems are encountered as in any other factory. There is variation in detail, the same as there is between an engine works and a silk mill, but the general principles are the same. Hence, it becomes important for the plant manager or chief engineer to look at his job and his problems with the same breadth of view as the factory manager.

In Mr. Saunders' address, printed in this issue, there is much which is worth careful consideration and fundamental principles, which will be a safe guide in managing any kind of a organization, are outlined and elaborated. For this reason, although its title does not seem to relate the article directly to the power plant, it is well worth study.

It is coming to be recognized, in nearly all industries that the kind of training given by engineering work is excellent in preparation for any business. While school courses are valuable as time savers in mastering the mathematics and scientific principles of engineering, nobody questions the possibility of getting fully as good a training outside of schools as in them. Men at the head of manufacturing plants, railroads and business firms have reached those positions by native talent and industry, through shop, plant and office, Mr. Saunders, himself, being a conspicuous example. And the engineer who masters and applies the principles of successful management in the power department of a works, has just as much opportunity to become the president of the company as the man who starts at the lathe or at a clerk's desk. In fact, the plant engineer who has studied questions of combustion, steam making, plant repairs, depreciation, upkeep and costs until he has achieved real plant management, as contrasted to just running, has a broader foundation for building a career than the man who begins and rises in any other department of the works.

The Eight-Hour Day

Adjusting the number of hours a day which employes shall work has become a serious matter, and in some instances has cost both sides a great amount of money and hardship. In some classes of work the 8-hr. day is practically universal, but not so in the power plant. This is especially true in small and medium sized plants, such as the electrical plant found in nearly every small town and operated by one engineer and one fireman on each watch, working on 12-hr. shifts. It is a question whether the 8-hr. basis would be feasible here. Men in the power plants of the government departments, like all other government employes are required to work only 8 hr. a day, and are given a vacation each year, usually on full pay. As a rule, the men are contented, and the best men in the vocation can be kept.

In many private plants, however, the employers cannot see any of the advantages of the shorter workday, and are slow to make the change. It is an established fact that higher efficiency is to be gained by the shorter workday, even though the wages are the same as for a longer day, and the resulting monetary gain from the higher efficiency of the men will, in a measure, balance the cost of employing an extra shift of men. The situa-

tion cannot always be judged by the cost in dollars and cents per man for labor. The reason for this is that it is nearly always possible to employ a smaller number of men on each watch because with shorter hours and an increased rate of pay per hour the men can, and will, be willing to work faster than they would when working long hours at a small rate per hour.

Taken in connection with the power plant, this is a subject that will admit of a great deal of argument on either side. With men working on 8-hr. shifts, many of them will spend several hours a day in addition to their work in study, which will help them to increase their effectiveness and better their positions, which is an advantage to the employer as well as the men.

As an instance, a man in the milling business, after studying the matter for some time, and before inaugurating the 8-hr. system, wrote to a large number of other employers in the same line. He was surprised to learn that although nearly all of the large mills were operated 24 hr. a day, in nearly all cases they were operated in 2 12-hr. shifts. He decided to give the matter a trial, and after 6 yr. experience with the 8-hr. workday said: "When running on 12-hr. shifts we required 22 men in the packing department on each watch, or 44 in all. When we changed to the 8-hr. basis we required only 15 on each watch, or 45 in all, so that practically each man did as much work in 8 hr. as he formerly did in 12.

"In the boiler room the conditions were even more pronounced. There we had 2 firemen working 12 hr. each. Their duties were to fire the boilers, clean out and wheel away the ashes. This was hot, hard work, and although we paid good wages, almost every week we had to get a new fireman. When we changed to 8-hr. shifts we had no more trouble. The men were satisfied with their work, and remained with us as good, loyal employes, and we have had no trouble in getting the very best men in this department.

"From our experience, although we pay our men the same wages for 8 hr. that we formerly did for 12 and in a few instances have had to employ extra men, I feel that in the quality of output, the steadiness of operation —in dollars and cents—it has been a profitable investment to our firm."

This firm's experience showed conclusively that they were ahead at the end of the year by adopting the 8-hr. workday. A better class of men could be kept, and they worked for the firm's interest.

From the point of the men themselves, there are 3 points to be considered—health, happiness, and morals. In the first 2, the men are sure to gain. In the third, this may or may not be true, depending on the individuality of the men. If the 8-hr. power plant man spends his leisure time in enjoying the society of his wife and children, in working around his home and garden, in reading or studying the books and magazines pertaining to his calling that he may become more proficient in his work, and better prepared to assume the responsibilities of a higher position, instead of spending it at the saloon in playing cards and spending money, reading uninstructive books or simply loafing, there will be gain in all 3 respects.

It must be conceded that if anybody is ambitious, and wishes to make a real success in life, he will not confine himself to working only 8 hr. a day.

Chief engineers of prominent plants who have made a place for themselves, without exception, worked in their early days, much more than that, and, even though the plants they now control are operated on an 8-hr. basis, most of them are still working many hours overtime.

When men are required to work 12 hr. a day little time is left for recreation or study, and the men are prevented from keeping up with the advancement of their work. For those men whose tendency is to spend their leisure time in loafing about the saloons, if the employer could fit up some spare room around the plant as a club room, with good magazines and books, billiard tables, and other games, and possibly provisions for athletic sports, the men would be drawn away from the saloon and its bad effect, and the higher efficiency of these men when at work would soon repay the expense of such recreation rooms. This would also bring employer and employe together with benefit to both. In many cases the expense of such a recreation room which should be open to everybody, from the president down, would be borne in part by the men paying a small amount each month for its maintenance.

News Notes

THE CASPER RANGER CONSTRUCTION CO. has been awarded the contract for the construction of a power house for the Claremont Paper Co. of Claremont, N. H.

DIRECTORS OF the Stow Manufacturing Co. take pleasure in announcing that D. Walker Wear, formerly purchaser of the Chicago Tunnel Co., has been elected vice-president and director of this company with offices at 443 State St., Binghamton, N. Y.

C. & E. ELECTRIC & MFG. CO. has discontinued its Pittsburgh office, in charge of Ludwig Hommel & Co., and this territory will now be taken care of by its Philadelphia Manager, J. C. Chamberlin. Also, F. A. Saylor with offices in the Greenwood Building, 6th & Vine Sts., Cincinnati, Ohio, will act as agent for the southern part of the State of Ohio.

CHARLES H. EGLEE, for 9 yr. general manager of the Ambursen Hydraulic Construction Co., in charge of their construction work, has just become connected with the Aberthaw Construction Co. of Boston, and will have charge of all dam and reservoir work for this company.

THE EXECUTIVE COMMITTEE of the State Capitol Commission, at Little Rock, Ark., approved the plans of E. C. Davis, of Kansas City, for the power house of the state capitol. It is to be located 600 ft. northwest of the building, fronting the new Third St. viaduct. It will be a thoroughly fireproof structure, 60 by 90 ft., with a smokestack 125 ft. high and 5 ft. in diameter. It will be connected with the basement of the capitol by a concrete tunnel, 5 by 7 ft., and through this the pipes and wires will be carried. Forty thousand dollars has been set apart for the work. It is expected the contract will be awarded about March 1.

Power Apparatus in Shop and Market

New Ideas In Making, Buying and Selling

The Baker Coal Storage Bunker

A NEW method of storage bin construction involving jointly the principles of design utilized in the well-known hopper and suspension types, has recently been introduced by Arthur G. McKee, contracting engineer, of Cleveland, O. This method of construction—the invention of Robert E. Baker, of Cleveland, O., possesses several unique features.

It is a fact well recognized by desiging engineers that the suspension type bin permits the most economical use of the construction material. This economy is made possible by utilizing the tensile strength of the materials composing the containing structure. The containing structure in bins of this type is usually parabolic in cross section.

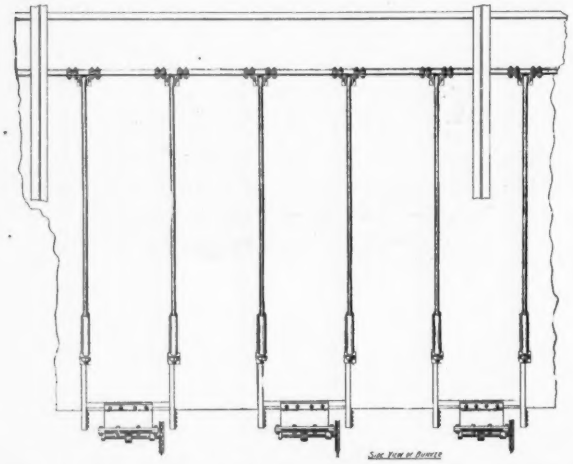


FIG. 1. SIDE VIEW OF BAKER SUSPENSION TYPE CONCRETE COAL BUNKER

In the Baker bin, a rigidly constructed hopper bottom is suspended from the supporting structure by means of tension rods. The container closely approximates a parabola in shape from the top of the container downwards until a point is reached where the bottom angle becomes less than the angle of flow of materials. From this point the rigid hopper bottom provides a predetermined definite slope to the point at which materials are discharged.

The supporting structure consists of columns connected by cross girders to form a bent. The containing structure is suspended by inclined girders attached to the supporting bents. Steel suspension rods are attached to these inclined girders, the number and size of rods being determined by the tonnage capacity of the bin per lineal foot. The rods are pin-connected to the inclined girders, and converge at their lower ends, at which point they are attached to rigidly constructed structural frames of triangular shape. Thus, there is formed a series of suspension units each consisting of 2 rods and a frame, on which the bin lining is laid.

The bin lining may be of either steel plate or concrete; from the standpoint of cost and durability, concrete is to be preferred. Two forms of concrete lining have been provided for this bin. In one form, "Asbestosteel," a standardized sheet metal product, has been used. This metal is provided with successive coatings of asphaltum and asbestos, rendering it practically immune from corrosion. The concrete lining, which varies from 2 to 4 in. in thickness, is laid directly on the Asbestosteel sheets. The lining supported by the rods is subject to bending and, to avoid cracking, this portion of the concrete lining is provided with a series of horizontal grooves, these grooves being filled with an asphaltum compound after the concrete is in place. Bending, therefore, takes place at the points where grooves are provided, leaving the concrete intact at all intermediate points. As the bottom lining is rigidly supported by the structural frames, cracking is prevented.

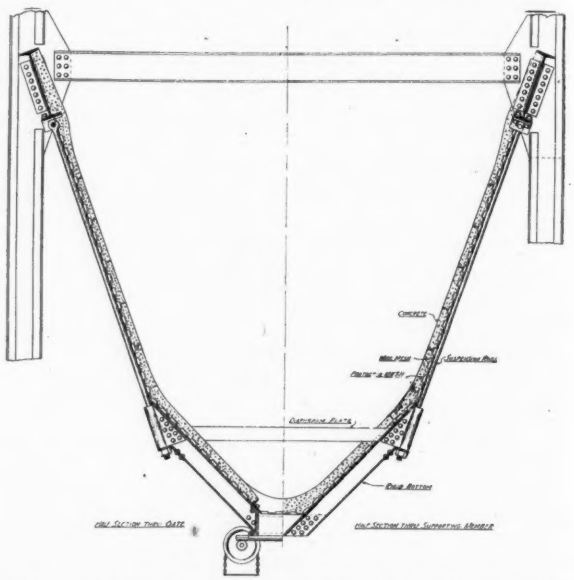


FIG. 2. END VIEW OF COAL BUNKER MADE OF ASBESTOSTEEL

The other form of lining used consists of a series of flat slabs 12 in. in width and of various lengths from 4 to 8 ft., the thickness being variable to conform to the

load sustained. The slabs are provided with a wire mesh reinforcement and have alternate edges made concave and convex. A rocking joint is thereby provided between adjacent slabs and the slight bend to which the lining is subjected occurs at these joints. The slabs are used only for that portion of the lining supported by the rods, the bottom lining being of Asbestosteel covered with concrete.

This design appears particularly adapted to boiler coal bunker construction. Its construction cost is low and it may be installed with a minimum of interference

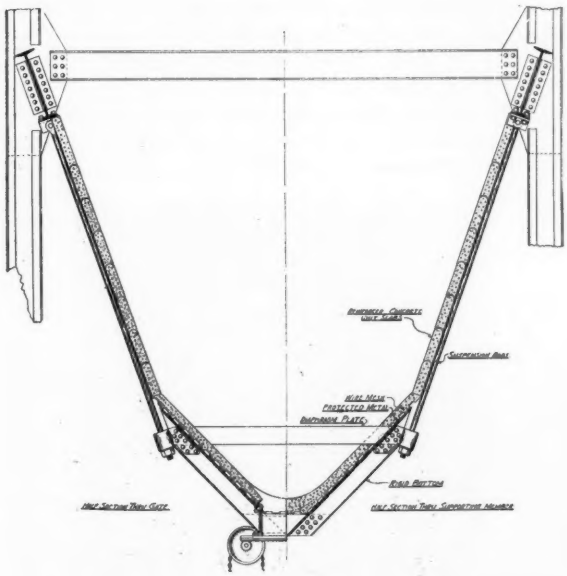


FIG. 3. END VIEW OF BUNKER LINED WITH UNIT CONCRETE SLABS

to plant operation. Maintaining the slope of sides and bottom at a comparatively large angle from the horizontal, minimizes the possibility of fire in the bunker, and permits of complete discharge of the coal should fire occur.

That the utility of this bin is not confined to coal bunker construction, and in illustration of its possibilities as a storage device for handling a widely variant class of materials, it may be noted that during the past year over 60 bins of this design—all of heavy steel construction—were installed for handling iron ore and limestone at blast furnace plants, the installation being made at Ironton, O., Pittsburgh, Pa., and Detroit, Mich.

Roto Tube Cleaners

REMOVAL of the scale from boiler tubes is one of the most important tasks in the power plant, both from the standpoint of safety and economy. To make this task easy, rapid, and positive as possible has been the aim in the development of Roto tube cleaners.

Roto appliances include air, steam and water driven tube cleaners for cleaning all types of boilers, condensers, heaters, evaporators, etc., with either straight or bent tubes.

For bent tubes of Stirling or other bent tube boilers, the Roto positive-balanced cleaner is specially suitable, because of its small size and weight, its adaptability to the form of the tube and the small hose used. For cleaning condensers, evaporators and other apparatus having tubes less than 2 in. in diameter, either straight or bent, the motor is used with an extension shaft which carried the cleaning tool. The light weight and absence of inertia allows the safe use of this motor for cleaning the thinnest and softest copper condenser tubes.

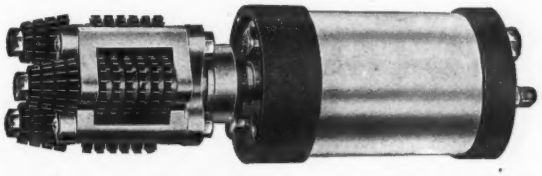


FIG. 1. ROTO TUBE CLEANER WITH SWING FRAME HEAD

The Roto positive-balanced motor is a positive acting, rotary engine. The general construction of it will be understood from the cut. The cylinder bore is not circular, and this feature allows the use of a single balanced blade which fits across the bore in all positions.

Direct pressure of confined air or steam, which is worked expansively on perfectly balanced rotary parts,

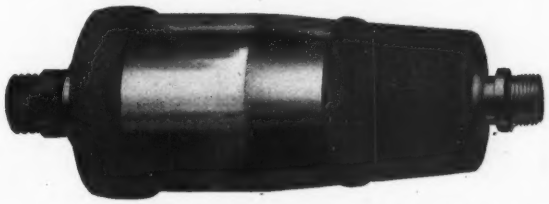


FIG. 2. ROTO MOTOR USED IN STIRLING BOILERS

combines the driving force of the piston engine with a speed almost as high as a turbine. The speed of the rotor is controlled by the air admission and is not at the mercy of the work that is being done at the moment.

At the ends of the motor, hardened steel armor rings, the size of the tube to be cleaned, are securely fitted

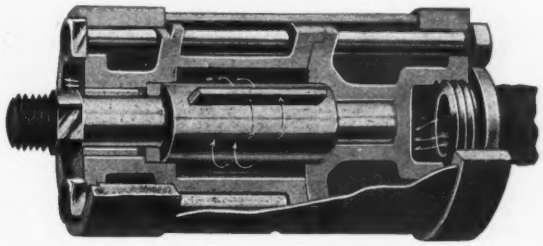


FIG. 3. INTERIOR VIEW OF ROTO MOTOR

to the motor and a seamless jacket thoroughly protects the motor. The steel rings keep it straight and round, up to size and a correct fit for the boiler tube, even after long use. The use of these rings prevents the motor from passing over scale or getting wedged or stuck in the boiler tubes. The front ring follows close behind the

cleaning head, thus insuring that the cleaner gets all the scale clean as it goes. The forward feed is almost automatic, and little time and effort is expended pulling and pushing the cleaner back and forth in the tube to find the scale.

The Roto motor is also adapted to general power purposes. In this case it is separate from the cleaner, and is built either for 2 speed or 1 speed. The 2-speed motor is provided with gears cut from solid steel which are enclosed in a gear casing completely covering them.

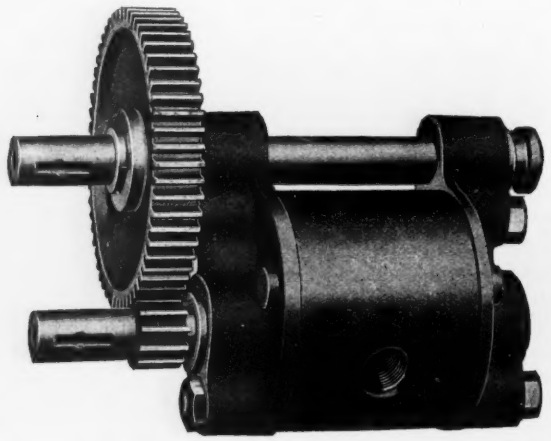


FIG. 4. TWO-SPEED ROTO POWER MOTOR DRIVEN BY AIR OR STEAM

Both the high and the low-speed shafts are arranged to receive an extension or tool, and each is fitted with a Woodruff key. This gives the 2-speed motor a ratio of about 5 to 1, and a corresponding strong turning effort on the slow speed shaft.

The Roto water turbine wheel has blades or buckets cut from the solid bronze and smoothly finished. The nozzles are taper reamed. The general design with the front wheel construction, allows the largest possible

FIG. 5. INTERIOR VIEW OF ROTO WATER TURBINE

diameter of circle for the intake of the nozzles and a smooth approach of the water to them. The water discharges from the wheel freely to escape without back pressure or churning. Hard steel armor rings are also provided to protect the motor from wear, keep it up to size, straight and round.

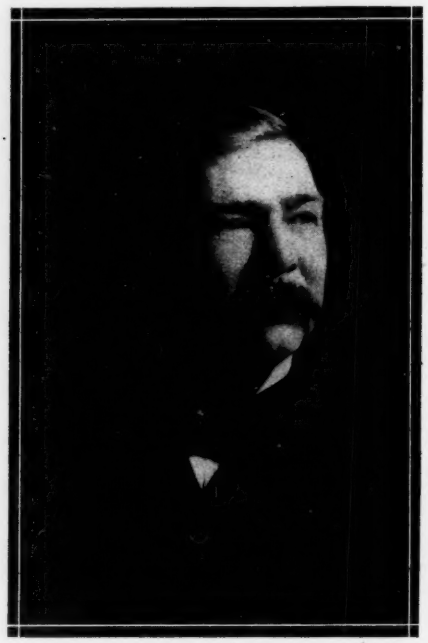
The Roto cleaners are provided with heads suitable for cleaning any size or type of tube free from hard or soft scale. These cleaners are the product of the Roto Co., Hartford, Conn.

Edwin Emerson Nolan

EDWIN EMERSON NOLAN, head of the Materials Disposition Department of the Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., died at his home at Wilkinsburg, Pa., on Tuesday, January 13.

Mr. Nolan was born in Chicago, August 10, 1857. He began work with the Westinghouse Electric Co. in 1887, just about the time it began operations on Garrison Alley in Pittsburgh. He was subsequently made superintendent of the Allegheny factory of the company and as such had charge of building the first alternating-current generators for the Niagara plant, an installation which afterward became famous throughout the world. He retained the position until the factory was converted into a foundry.

In 1898, Mr. Nolan was sent by the Westinghouse Electric & Mfg. Co. to France to establish a factory at Havre, in which position he remained until 1902.



At this time he returned to the United States, and on account of his familiarity with Westinghouse apparatus was placed in charge of the Materials Disposition Department, a position which he held until his death.

Mr. Nolan received his early education in Mexico, and from his sojourn among the foreign population acquired a ready speaking knowledge of several foreign languages which made his services unusually valuable to the company in dealing with its numerous foreign interests. He was a mechanical engineer and an inventor of considerable ability, one of his inventions being now in use on the modern street railway motor as manufactured by the Westinghouse Co.

He was noted for his thoroughness in all undertakings, and was an exceedingly reliable and conscientious employe. His kindly disposition and method of dealing with men endeared him to the large number of acquaintances which he had made in this country and in many foreign countries.

Dr. John E. Sweet

TO every one who knows the man or knows of his work in the field of engineering, the conferring of the degree "Doctor of Engineering" upon Prof. John E. Sweet, of Syracuse, by the Board of Trustees, of Syracuse University, will seem a gracious act, well deserved as the crown to a lifetime of achievement.

Dr. Sweet, who is president of the Straight-Line Engine Co., is widely known for numerous inventions, including the oil ring for bearings, the matrix compositor, which was the first step toward the linotype machine, the Sweet governor, the Sweet balanced valve, and many devices in lines outside the engine field.

His public services have been numerous and helpful. He was Professor of Engineering at Cornell University, was one of the founders of the American Society of Mechanical Engineers, and its third president, the first president of the Engine Builders' Association of the United States, and has served on many boards and committees which have worked for the advancement of engineering education and of the engineering profession.

In honoring Prof. Sweet, Syracuse University not only does a just act, but honors itself as well.

Catalog Notes

FROM BAYER Steam Soot Blower Co., St. Louis, Mo., we have received a folder entitled, "The Bayer Front End Fire-Tube Blower and Its Advantages."

THWING INSTRUMENT CO., 445 North 5th St., Philadelphia, recently issued Bulletin No. IV on Radiation Pyrometers, and Bulletin No. V on Recording Pyrometers.

BLACKMERE & POST Pipe Co., St. Louis, Mo., has recently issued a 38-page catalog describing and illustrating its vitrified sewer pipe, flue linings, socket chimney pipe, etc.

TRIPLE TESTED is the title of a circular just issued, relating to Nelson iron body gate valves. This may be had by addressing Nelson Valve Co., Chestnut Hill, Philadelphia.

"ROCKWELL FURNACE SERVICE for Industrial Heating Operations," Publication No. 20, illustrates a partial list of the furnaces built by W. S. Rockwell Co., 50 Church St., New York.

THE GENERAL ELECTRIC CO. has just issued Bulletin No. A4199, which illustrates and describes that company's railway motor gears and pinions. The bulletin contains curves and data which will be of especial interest to purchasers of this material.

BURNING S. S. VOLTURNO is represented in the cover design of the latest Grinnell automatic sprinkler bulletin. This pamphlet, No. 75, relates to fire tragedies of the sea, and is published by the General Fire Extinguisher Co., Providence, R. I.

STANDARD REINFORCED Spiral Pipe is the subject of Catalog No. 4 from Standard Spiral Pipe Works, Chicago, Ill. The catalog also describes forged steel flanges, valves, cast-iron fittings and specialties used in connection with the pipe.

STEEL WATER TOWERS booklet for 1914 was lately received from Chicago Bridge & Iron Works, Chicago.

A FEW of the portable tools made by Stow Mfg. Co., Binghamton, N. Y., are described and illustrated in a recent circular.

STEAM SPECIALTIES, Catalog No. 3A, describing balanced float valves, balanced control, pump, regulating and many other varieties, has just been issued by Schade Valve Mfg. Co., 2528-2538 N. American St., Philadelphia, Pa.

BOSTON TYPE BLOWER is illustrated in Bulletin No. 18 from The Connersville Blower Co., Connersville, Ind, Information is given as to the proper blowers for certain capacities, with the accompanying speeds and power requirements. A type of valveless rotary pump for use with the blower is also shown.

BELTING MANUAL, the new edition of The Graton & Knight Mfg. Co.'s book on Care of Belting, contains additional mechanical rules and tables, new rules for lacing belts, suggestions for ordering belting, comparison of various forms of power transmission, etc. Buyers, managers or foremen may obtain the manual by writing to the company at Worcester, Mass.

ELECTRIC CONVEYOR SCALES, described in a pamphlet recently received, include conveyor scales for belt and pan conveyors and duplex scales for pivoted bucket carriers. These are self-registering scales for weighing materials while in motion on conveyors. The manufacturer is Electric Weighing Co., 180 13th Ave., New York.

THE RUSSIAN EMPIRE, covering 1/7 of the land area of the globe and only sparsely settled in spite of its nearly 170,000,000 inhabitants, offers an interesting subject for study for both business men and economists. This country today presents a picture of economic development comparable with that of the United States of 3 or 4 generations ago. Its exports are almost entirely foodstuffs and raw and semimanufactured products, while it imports nearly all of the higher grades of manufactures which its people require. Largely owing to the lack of knowledge among American business men of the possibilities of the Russian market, the trade between the 2 countries is on the threshold only of its possible development. The monograph on Russia just published by the Bureau of Foreign and Domestic Commerce, Washington, D. C., entitled "Handbook on Russia," should be of interest. This book contains nearly 260 pages, with 2 maps, and includes a comprehensive description of the economic situation in European Russia, by Consul General John H. Snodgrass, stationed at Moscow; reviews of the commerce of various districts in 1912, by the American consuls stationed in Russia; and a timely description of commercial and industrial conditions in Siberia, by Consul John F. Jewell, stationed at Vladivostok. To those who still regard that country as a frozen waste the picture presented by Mr. Jewell will be a revelation. He compares Siberia today with Canada of a generation ago, and points out the possibilities of great trade development that lie in the

great natural resources of the country. Copies of the bulletin (Special Consular Reports No. 61, Handbook on Russia) may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., for 50 cents each.

Trade Notes

TRAPS MADE by Armstrong Machine Works, Three Rivers, Mich., which heretofore have been known as the "Superior," will in future be marketed as "Armstrong" traps, but will have the same design, features and advantages as under the other name, the change being in order to identify the trap with its makers and with the other quality products of the Armstrong Machine Works.

AMERICAN ENGINEERING CO. reports the following recent sales of Taylor stokers: New York Dock Co., New York City, one 2-retort stoker to be used for burning cocoanut shells; Solvay Process Co., Solvay, New York, two 2-retort stokers (repeat order); Kansas Chemical Co., Hutchinson, Kansas, one 2-retort stoker with extension grate (repeat order); United Illuminating Co., New Haven, Connecticut, two 7-retort stokers with extension grates (repeat order); Dominion Power & Transmission Co., Hawkesbury, Canada, four 11-retort stokers with extension grates; Connecticut Co., Bridgeport, Connecticut, one 6-retort stoker with extension grate (repeat order); Louisville Cement Co., Speeds, Indiana, one 4-retort stoker with extension grates; Pennsylvania Railroad Co., Long Island City Power Plant, sixteen 7-retort stokers with extension grates (repeat order); United States Aluminum Co., New Kensington, Pa., two 5-retort stokers with extension grates (repeat order).

ADOPTION OF THE low-pressure turbine in connection with reciprocating engines calls for a particularly efficient separator to remove the oil and water from the exhaust steam before it enters the turbine. The Direct Separator Co. of Syracuse, N. Y., is making a machine for this purpose and among recent sales are the following: Pacific Lumber Co., San Francisco, Cal., 1 20-in.; John B. Stetson Co., Philadelphia, Pa., 1 20-in.; Allis-Chalmers Mfg. Co., Milwaukee, Wis., 1 20-in.; National Biscuit Co., New York, 1 20-in., 1 24-in.; Union Pacific Coal Co., Rock Springs, Wyo., 1 14-in., Cambridge Electric Light Co., Cambridge, Mass., 1 18-in.; Pennsylvania Steel Co., Steelton, Pa., 1 24-in.; D. L. & W. R. R. Co., Scranton, Pa., 1 24-in.

THE NEW FACTORY recently erected for the Calumet Baking Powder Co., 41st Ave. & Fillmore St., Chicago, Ill., is equipped with Monash noiseless system of vacuum heating and drying apparatus; Richard E. Schmidt, Garden & Martin, architects, Mehring & Hanson Co., heating contractors.

IN THE JANUARY 1 issue, the Hays Automatic CO_2 and Draft Recorder, and the Hays Gas Analysis Instrument were described as being manufactured by G. L. Simonds & Co., of Chicago. In fairness it should be stated that The William B. Pierce Co., of Buffalo, N. Y., also manufactures and handles these instruments.

PRACTICAL ENGINEER
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Front cover, $150.00 per issue.

Other specified positions, regular rate plus 10 to 50 per cent.

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Per line, 30 cents each insertion.

Advertisements in this section are inserted under regular headings.

No display type allowed, but the first three words may be set in capital letters.

About nine words make a line. Minimum space sold, two lines.

Under classification "Position Wanted," advertisements not exceeding four lines will be inserted once for subscribers free of charge.

All copy should be received at Chicago office 18 days before date of publication.

Circulation of this issue, 22,500

Technical Publishing Co.
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Chicago

Position Wanted

POSITION WANTED—By young man as assistant in large plant or to take charge of small plant; own indicator and can use it. Can furnish references. Address Box 331 Practical Engineer. 2-1-1

POSITION WANTED—By young man, as second or assistant engineer of power or heating plant. Recent graduate of Mechanical Engineering College, University of Wisconsin. Have had considerable shop experience. At liberty Feb. 1st. Address Box 332, Practical Engineer.

POSITION WANTED—By Gas Engineer, experienced on large engines, desires steady position in small city or country town. Have no experience with gas producers, but have studied their operation; have little experience with d.c. electrical apparatus. Address Box 333, Practical Engineer. 2-1-1

Wanted

IF YOU RECOGNIZE the value of approved specialties in an engine and boiler room as a means of higher efficiency; if you believe in this sort of thing to the extent that you think your could sell a well-known boiler specialty in your territory for an old established manufacturer in the power plant field, write and tell us all about yourself. On receipt of your letter we will outline our proposition in full. Address Box 324, Practical Engineer. tf.

WANTED—EVERY ENGINEER to have our pamphlet for setting valves on Corliss Engines, single and compound, with one or two eccentrics. Sent free. Lindstrom's Machine Works, 200 South Third St., Allentown, Pa. tf.

WANTED—Every local Engineers' Association to have an assortment of valuable power-plant books—Secretary write at once, for full particulars. Address Dept. C., Practical Engineer, Chicago.

IF YOU ARE a night engineer, spend a few hours each day taking subscriptions for Practical Engineer. You will be paid well. Write Subscription Dept. They will start you in at once.

WANTED—ALL STEAM USERS to have clean boilers without using compounds or chemicals in any form. Write "Otis," No. 317 Norfolk Ave., Buffalo, N. Y. tf.

WANTED—Secretary of local Engineers' Association to write us at once in regard to a very interesting proposition. Address Practical Engineer, Circulation Department.

Help Wanted

WANTED—An additional subscription solicitor wanted to cover towns in the state of Indiana. Excellent chance to earn extra money. Write to Subscription Department. tf.

WANTED SALESMAN—MUST HAVE engineering training and be familiar with temperature controlling apparatus. H. & M. Division, Taylor Instrument Cos., Rochester, N. Y. 2-1-1

For Sale

GROBET SWISS FILES are the standard of excellence in files, and have been for over 100 years. We send post paid, as an introducer, 48 files especially adapted for tool makers and machinists on receipt of $5.00. This is a chance to get a set of files you'll appreciate and we'll get future orders. Montgomery & Co., 101 Fulton St., New York, N. Y. 2-1-1

DIRECT CONNECTED GAS Units—100 K.W. Westinghouse 250 volt generator, with Westinghouse 3-cylinder gas engine, $2,500. 75-K.W. Crocker Wheeler 250-volt generator, with Nash 3-cylinder gas engine, $2,000. 50-K.W. Westinghouse 125-volt generator, with Westinghouse 3-cylinder gas engine, $1,350. Duzets & Son, 50 Church St., New York. Send for complete "Bargain List." 2-1-2

FOR SALE—A No. 1 R. H. American Thompson Improved Indicator, outside spring, detent motion. Three-way cock and special reducing wheel for 8-inch stroke, with extra bushings for 10-inch, 12-inch, 14-inch, and 16-inch strokes. One 20-lb., one 30-lb., one 40-lb., and one 50-lb. spring outfit. Cost $100.00. Has had very little use and is practically new. Will sell for $50.00. Thos. H. Dallett Co., Broad and Federal Sts., Philadelphia, Pa. 2-1-1

FOR SALE—20 by 42-in. Corliss 16 ft. 36-inch wheel, $800. 22 by 48-inch Brown 16 ft by 26-inch wheel, $900. 14-in. 22 by 15 Harrisburg 6 ft. by 32-inch wheel, $800. 2 175-Hp. Vertical boilers 125 lb., $1200. 900-ft. air compressor, $2100. $100 com. of allowance an freight. J. F. Foster, 90 Canal St., Boston, Mass. 2-1-1

FOR SALE—14 by 42 Wheelock Engine Wheel 9 ft. by 20 ins. Also Bulkley Condenser in first class condition, and National Heater with double coil, back pressure valve and exhaust head. Address M. Heminway & Sons Silk Co., Watertown. Conn. 2-1-2

OUR MODERN BLUE PRINT CHART method of electrical wiring. Write for information. Electrical Wiring Diagram Co., Box F173, Altoona, Pa. 11-15-12

Patent and Patent Attorneys

PATENT SECURED or fee returned—Send sketch for free expert search and report as to patentability. Books on inventions and patents, and reference book sent free. John S. Duffie & Co., 607 F St., Washington, D. C. tf.

PATENTS THAT PROTECT AND PAY. Advice and books free. Highest references. Best results. Promptness assured. Send sketch or model for free search. Watson E. Coleman, Patent Lawyer, 624 F Street, Washington, D. C. tf.

PATENTS—C. L. Parker, Attorney-at-Law and Solicitor of Patents. Patents secured promptly and with special regard to the legal protection of the invention. Handbook for inventors sent upon request. 186 McGill building, Washington, D. C. tf.

PATENTS—H. W. T. Jenner, Patent Attorney and Mechanical Expert, 606 F St., Washington, D. C. Established, 1883. I make a free examination and report if a patent can be had and the exact cost. Send for full information. tf.

PATENT WHAT YOU INVENT. It may be valuable. Write me. No attorney's fee until patent is allowed. Estab. 1882. "Inventor's Guide" FREE. Franklin H. Hough, 357 Loan & Trust Bldg., Washington, D. C. 2-1-2

PATENTS SECURED. Legal protection our specialty. Booklet free. Harry Patton Co., Suite 330, McGill Building, Washington, D. C. tf.

OFFICIAL Drawings Free. Patents procured or fee returned. Expert services. Send sketch for Free search. The Patent Exchange, Garban Bldg., Washington, D. C. tf.

PATENTABLE IDEAS WANTED—Send for 3 free books. R. B. Owen, 28 Owen Bldg., Washington, D. C. tf.

Educational and Instruction

CARNEGIE COLLEGE—Home Study—Free Tuition to one representative in each county and city. Normal, Academic, Civil Service, Mechanical Drawing, Stationary Engineering, Electrial Engineering, Electric Wiring, Agriculture, Poultry Culture, Bookkeeping, Shorthand, and Typewriting Courses. Apply at once for Free Tuition for Mail Course to Carnegie College, Rogers, Ohio. 2-1-1

PROF. ARTHUR BATEMAN, who has been a practical teacher for 11 years, in 4 different institutions, in 2 countries, teaches by mail Sanitary Engineering, Sanitary Inspection, Plumbing, Hygiene. Booklet free. Write Desk 2, Anglo-American Sanitary Correspondence College, 12 W. Ontario Street, Chicago, Ill. 1-1-4

ENGINEERS' POCKET MANUAL, 175 pages, edited by University of Tennessee, will be mailed every subscriber sending in one new subscription to Practical Engineer. Gilt edges; bound in leather.

Technical Books

ENGINEERS AND FIREMEN—Send 10c in stamps for a 40-page pamphlet containing a list of questions asked by an examining board of engineers. Stromberg Publishing Co., 2703 Cass Ave., St. Louis, Mo. 2-1-1

Miscellaneous

ENGINEFRS—DO YOU WANT to utilize your exhaust steam for heating or drying purposes, without back pressure on your engine? If so, address Monash Engineering Co., 1413 W. Jackson Blvd., Chicago, Ill. tf.

MAKE MONEY on the side. Here's your chance to work out some money for yourself. Get subscriptions for Practical Engineer. It pays well. Just drop a line to the Subscription Dept. They will tell you. tf.

Sparks From The Advertising Pages

Down at Washington, in the House of Representatives, they had a discussion the other day on the subject of fraudulent advertising. In a speech on the Post Office Appropriation Bill, Representative Steenerson of Minnesota advocated the punishment of authors of such advertising.

"Hundreds of millions of dollars are transferred annually from the pockets of the honest people of the United States, to the pockets of swindlers, rascals, and thieves by means of fraudulent, dishonest, and false advertising," he said. "We have excluded from the mails absolutely all matter that might be construed to be immoral, but there is still a great field for fraud upon the people.

"I have introduced several bills on this subject. My proposition was to exclude from the mail, or at least from the second class privilege, publications carrying pictorial advertising in regard to liquor and tobacco.

"If any one of you has taken the trouble to read one of those advertisements, for instance, say of some rotten brand of whiskey sold up here somewhere in the state of New York, you have noticed they print pictures of venerable men and ladies, and that they tell the most outrageous lies about what this whiskey has done for them, and, of course, they must necessarily succeed in deluding some people.

"Does the gentleman refer to such concoctions as Peruna?" Representative Stafford of Wisconsin inquired.

"I had reference to these liquor advertisements," Steenerson replied. "But closely connected with them are these advertisements of quack remedies. The gentleman is absolutely right. That is perhaps a more successful swindle than any other, and the Government aids in carrying on that business at a loss.

"I introduced another bill which goes further, and I think perhaps it would be sufficient. That bill provides a punishment for the man who inserts a false advertisement in a paper, intending it to be circulated through the mails. That is simply supplementing the legislation of the states against false advertising.

"There has been an awakening of late about this question of dishonest and false advertising. Even the better class of newspaper and advertising agencies have held meetings and discussed it, and they favor laws regulating advertising.

"The state of Pennsylvania lately passed a stringent law regulating advertising, and I believe Massachusetts and New York have laws of that kind. I say my proposition is to supplement the state laws so as to make them more effective."

The percentage of advertising which is fraudulent is really very small, but so determined are the better class of publishers and advertisers to bring publicity to the point where no breath of suspicion can be turned against it, that only a question of time remains until it is 100 per cent pure.

Practical Engineer is heartily in favor of any process or law which will hasten the arrival of this time. It does not believe its readers need any protection from any advertiser in the power plant field, but in the larger field of general advertising it is hardly possible for the publisher to have so thorough an acquaintance with the advertiser, therefore, a stringent law would be added security.